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JULY 1981

MILITARY HANDBOOK

AIRFIELD LIGHTING

AMSC N/A

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ABSTRACT

This handbook contains design criteria for facilities and systems in Category Code 136 and is intended for use by experienced architects and engineers. It covers the design of high and medium intensity approach light systems, and runway end identifier lights, taxiway lighting, helipad lighting systems, apron, parking area, direct fueling station, and emergency portable lighting for airfield.

For the lighting systems cited above, this handbook provides criteria on the siting, configuration, equipment requirements, power and control requirements, and installation methods to be employed in their design and construction. It also provides information on compliance with international military standards to which the United States subscribes.

FOREWORD

This handbook has been developed from an evaluation of facilities in the shore establishment, from surveys of the availability of new materials and construction methods, and from selection of the best design practices of the Naval Facilities Engineering Command (NAVFACENGCOM), other Government agencies, and the private sector. This handbook was prepared using, to the maximum extent feasible, national professional society, association, and institute standards. Deviations from this criteria, in the planning, engineering, design, and constructions of Naval shore facilities, cannot be made without prior approval of NAVFACENGCOM HQ Code 04.

Design cannot remain static any more than can the functions it serves or the technologies it uses. Accordingly, recommendations for improvement are encouraged and should be furnished to Commander, Pacific Division, Code 406C, Naval Facilities Engineering Command, Pearl Harbor, Hawaii; telephone (808) 471-8436.

THIS HANDBOOK SHALL NOT BE USED AS A REFERENCE DOCUMENT FOR PROCUREMENT OF FACILITIES CONSTRUCTION. IT IS TO BE USED IN THE PURCHASE OF FACILITIES ENGINEERING STUDIES AND DESIGN (FINAL PLANS, SPECIFICATIONS, AND COST ESTIMATES). DO NOT REFERENCE IT IN MILITARY OR FEDERAL SPECIFICATIONS OR OTHER PROCUREMENT DOCUMENTS.

AIRFIELD LIGHTING AND NAVIGATIONAL AIDS CRITERIA MANUALS

Criteria Manual	Title	PA
MIL-HDBK-1023/1	Airfield Lighting	PACDIV
DM-23.02	Navigational and Traffic Aids	WESTDIV
MIL-HDBK-1023/3	Aircraft Pavement and Obstruction Marking (Proposed)	LANTDIV

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AIRFIELD LIGHTING

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xvi	15 October 1990	xvi	29 January 1988
xvii	15 October 1990	new page	
81	15 October 1990	81	29 January 1988
82	15 October 1990	82	29 January 1988
83	15 October 1990	83	29 January 1988
84	15 October 1990	84	29 January 1988
84a	15 October 1990	new page	
84b	15 October 1990	new page	
84c	15 October 1990	new page	
84d	15 October 1990	new page	
84e	15 October 1990	new page	
84f	15 October 1990	new page	
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85	30 September 1995	85	29 January 1988
86	30 September 1995	86	29 January 1988
87	30 September 1995	87	29 January 1988
88	30 September 1995	88	29 January 1988
89	30 September 1995	89	29 January 1988
90	30 September 1995	90	29 January 1988
91	30 September 1995	91	29 January 1988
92	30 September 1995	92	29 January 1988
92a	30 September 1995	new page	
92b	30 September 1995	new page	
92c	30 September 1995	new page	
92d	30 September 1995	new page	
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93	30 September 1995	93	29 January 1988
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AIRFIELD LIGHTING

CONTENTS

Page

Page

Page

Page

Page

FACILITY PLATES

FIGURES

Section 1: INTRODUCTION

1.1 Scope. This handbook contains data and information comprising standards for the following lighting systems used for aircraft guidance during approach, landing, takeoff, taxiing, and parking operations:

a) Approach lighting,
b) Runway edge lighting,
c) Threshold and runway end lighting,
d) Runway centerline lighting,
e) Touchdown zone lighting,
f) Circling guidance lights,
g) Simulated carrier deck lighting,
h) Wheels-up and runway waveoff lighting,
Taxiway lighting,
i) Helipad lighting, and
j) Parking and service area lighting.

The handbook applies to new installations only. Its application to renovations and relocation work will be dependent on existing conditions and the equipment to be installed.

All installations of the lighting systems listed above shall conform to the Standards. Where local conditions necessitate deviations, prior approval must be obtained from Naval Facilities Engineering Command (NAVFACENGCOM).

1.2 Cancellation. This handbook cancels and supersedes NAVFAC DM-23.1, Airfield Lighting, dated July 1981.

1.3 Requirements of Other Commands. The overall system configurations and performance requirements for Airfield Lighting Systems are established by Naval Air Systems Command (NAVAIRSYSCOM) and are contained in NAVAIR Technical Manual 51-50AAA-2, General Requirements For Shorebased Airfield Marking and Lighting. Unless otherwise advised by NAVAIRSYSCOM, NAVAIR 51-50AAA-2 takes precedence for all matters concerning the configuration, siting, or light output requirements of airfield lighting systems; In matters of construction methods, installation techniques, or equipment specification, Technical Manual 51-50AAA is considered advisory.

1.4 Definitive Designs. The data in definitive designs for Naval Shore Facilities, Definitive Design Drawings, NAVFAC P-272, are an integral part of the NAVFACENGCOM design program. Definitive designs associated with this handbook, as listed below, may be used for guidance in acceptable design principles related to specific functional layouts and operational requirements. As of the date of this publication the airfield lighting definitive drawings are undergoing revision. The P-272 directory should be consulted to identify the latest definitive drawings for any system. Unless otherwise advised, the requirements of this handbook shall take precedence over the Definitive Design Drawings.

The following definitive design drawings are applicable in this handbook:

NAVFAC P-272 Drawing No.	Title
1403042	Direct Fueling Station, Helicopter and Fixed Wing Aircraft, Plan and Installation Details
1404275	Approach Lighting System, Plan Layout, Elevation/Aiming Plan, Visibility Plan
1404276	Approach Lighting System, Approach Lighting Vault, One Line and Block Diagram
1404277	Approach Lighting System, Series Wiring, Fixture Schedule, Circuit Load Schedule
1404278	Approach Lighting System, SFL Wiring Diagram & Substation
1404279	Approach Lighting System, Threshold, 500 Foot & Wing Bars, Road Sections
1404280	Approach Lighting System, Termination, 1000 Foot Cross and Centerline Bars
1404281	Approach Lighting System, Light Bar Sections, Tower and Miscellaneous Details
1404282	Runway Lighting, Edge Lights and Distance Markers-Plan
1404283	Runway Lighting, Circling Guidance, Touchdown Zone and Centerline Plans & Typical Wiring
1404284	Runway Lighting, Identification and Edge Lights Installation Details and Schedule
1404285	Runway Lighting, Circling Guidance and Edge Lights Installation Details
1404286	Runway Lighting, Touchdown Zone and Threshold Lights Installation Details
1404287	Runway and Taxiway Lighting, Inset Fixture & Wiring Installation Details
1404288	Runway Lighting, Ductline Plan, Handhole Details
1404289	Simulated Carrier Deck Lighting, Plan and Wiring Diagram
1404290	Simulated Carrier Deck Lighting, Details
1404291	Wheels Up and Runway Waveoff Lighting, Plan, Wiring Diagrams and Details
1404292	Wheels Up and Runway Waveoff Lighting, Wiring Diagram- and Details
1404256	Wheels Up and Runway Waveoff Lighting, Equipment Vault Plans
1404510	MALSR Plan and System Details
1404511	MALSR System Riser Diagram
1404512	MALSR System Schematic Diagram
1404513	MALSR System Equipment Mounting Details
1404514	MALSR Tower and Foundation Details
1404515	MALSR 1,000 Foot Crossbar and Foundation Details

1.5 International Military Standards. The USN has agreed to conform to the criteria of certain International Treaty Organizations for Visual Aids to Air Navigation at locations covered by the treaty agreement. Insofar as is

possible, the standards and criteria for Airfield Lighting Systems contained in this handbook satisfy the requirement of these international military standards. Because of divergences between the standards of the various organizations involved, it has not been possible to comply in all respects. The following international military standards apply:

a) the North Atlantic Treaty Organization (NATO), which develops standards (known as NATO Standardization Agreements (STANAGs)) that are promulgated by the NATO Military Agency for Standardization (MAS).

b) the Air Standardization Coordinating Committee (ASCC) consisting of representatives of the United States, Canada, Australia, New Zealand, and the United Kingdom. Their standards are known as ASCC Air Standards (AIR STDs).

The standards and criteria contained in this handbook, which satisfy the various international military standards, have been identified in each system standard. The applicable international military standard shall take precedence over the standards contained in this handbook when designing facilities to be installed at covered locations.

1.6 Operational Categories. The operational Categories for airfield lighting are provided in paras. 1.8.1 and 1.8.2.

1.6.1 Visual Flight Rules. When Visual Flight Rules (VFR) are in effect, the meteorological (met) visibility is generally 3 miles (5 km) or greater; or the ceiling is 1,200 ft (365.7 m) or greater in controlled air space.

1.6.2 Instrument Flight Rules. When the met weather/visibility conditions Instrument Flight Rules (IFR) are in effect, visibility is below 3 miles (5 km); or the ceiling is less than 1,200 ft in controlled air space. There are several subcategories of IFR operation; These are:

a) Category I (Cat. I) - Cat. I covers visibilities from 3 miles (5 km) down to Runway Visual Ranges (RVR) of 2,400 ft (731.5 m).

b) Category II (Cat. II) - Cat. II covers conditions below 2,400 ft (750 m) RVR down to 1,200 ft (360 m) RVR.

c) Category III (Cat. III) - Cat. III covers all visual ranges below 1,200 ft RVR.

1.7 General Design Criteria. The general design criteria described in paras. 1.9.1 through 1.9.9 shall apply to all facilities covered by this handbook unless modified by special instructions to the designer or by the specific criteria for the lighting system contained elsewhere in the handbook.

1.7.1 Light Fixture Mounting. Wherever practical, the light fixtures shall be mounted on mounting bases installed in a concrete envelope or concrete handholes as illustrated in NAVFAC P-272. The mounting bases support the light fixtures and generally house the isolating transformers. For temporary construction, the light fixtures may be stake-mounted with direct burial of isolation transformers and cables.

1.7.2 Cable and Installation. Cable insulation shall be suitable for underground installation. Wherever practical, all cables are to be run underground, in either concrete encased or direct buried duct. Concrete encased duct is preferred under paved aircraft traffic areas (across runways, taxiways, ramps, etc.), except when installation under existing pavement is required, rigid steel conduit may be used. Direct buried duct may be used under paved shoulders. For temporary construction, the cables may be direct buried. Connections between the lighting cable, isolation transformers, and light fixtures are to be made by watertight connectors. Cables for new taxiway centerline, runway centerline, and Touchdown Zone Lights (TDZL) shall be installed in flexible or rigid conduit in saw kerfs in the pavement. Cables which are installed directly in saw kerfs may continue to be employed in existing in-pavement lighting systems. Although direct installation in saw kerfs is permitted, care must be taken to constrain the cable below the pavement surface and to protect it from damage resulting from differential expansion or movement.

1.7.3 Grounding System. A counterpoise of number 4 AWG bare, stranded copper wire shall be laid continuously for the entire length of all primary circuits that supply airfield lighting.

The counterpoise shall be laid above the uppermost layer of direct buried ducts, or on the top of the concrete envelope of an encased duct bank. Only one counterpoise wire shall be installed for the cables in a common duct bank. All counterpoise wires leading to a duct bank shall be exothermically bonded to the single counterpoise wire in the duct bank. The counterpoise shall be exothermically bonded by a number 6 AWG bare stranded copper wire to the metal base (or metallic mounting structure) of each lighting unit, and to the lighting vault power grounding system at one point.

1.7.4 Frangibility and Accident-Avoidance Construction. In areas around the runway, including the approach zone, all above-grade structures shall be lightweight and of a frangible or low-impact-resistant construction, using breakaway sections to minimize hazards to aircraft. Concrete foundation or mounting slabs shall not extend above the finished grade of the surrounding surface.

1.7.5 Airfield Lighting Vaults. Vault construction in the past was generally provided with a primary service of e.g. 4,160 V/2,400 V, 3-phase, 60 Hz power. For new power vault construction, or major modernization or expansion, the following factors shall be considered before deciding on the power distribution system and type of vault to be constructed.

All floor and wall-mounted equipment shall be securely mounted or restrained to prevent movement during seismic disturbances.

1.7.5.1 Life Cycle Cost Analysis. A life cycle cost analysis shall be made to consider using 240 V or 480 V as the primary voltage within the vault. Savings may be realized in the cost of regulators, switchgear, and engine/generators, in building space requirements, and in the cost of system maintenance even though there may be a requirement to reduce the distribution system voltage at the service entrance.

1.7.5.2 Main Airfield Lighting Vault. The main airfield lighting vault, houses power distribution and control equipment for runway and taxiway lighting circuits and any other airfield lighting that can feasibly use this source. Auxiliary vaults may be required for other systems depending upon airfield configuration. Vaults are located above grade at locations most suitable as supply points.

1.7.5.3 Approach Lighting Vault. The approach lighting vault shall house power distribution and control equipment primarily for the approach lighting and sequenced flashers. Other nearby lighting systems may also use this vault as a power source. The vault shall be located adjacent to the approach zone at a sufficient distance to satisfy obstruction criteria.

1.7.6 Emergency Power. An emergency generator or other independent power source shall be provided at each vault to ensure continuous operation should the primary power source fail.

1.7.6.1 Engine Generator. Where Engine Generators (E/G) are installed, they shall be installed in separate rooms or shelters that have been provided with independent ventilation. Provision shall be made for engine exhaust to the exterior of the shelter. Mufflers may be installed inside or outside the building, however, if installed inside they shall be insulated. Engine cooling may be provided by externally-mounted radiators or through the use of a radiator duct to an external exhaust louver. Provision shall be made for resistive load banks for diesel engine testing where the station load is inadequate or cannot be made available for engine testing. Fuel storage shall have sufficient capacity for a minimum of 72 hours of operation.

Engine generators shall be provided with automatic starting and switching capability and shall be capable of supplying the rated load within 15 seconds of a power failure except during Cat. II instrument operations. During Cat. II instrument operations a one second power transfer is required. This is normally achieved by providing a remote start capability which will permit operation of the engine generator during Cat. II weather conditions so that emergency power availability is subject only to switching time. Refer to Federal Aviation Administration (FAA) Advisory Circular 150/5340-17, Standby Power for Non-FAA Airport Lighting Systems, for additional information on how this may be achieved. An automatic battery charger is required for maintenance of starting batteries. The E/G foundation slab shall be isolated to reduce vibration and noise transmission to other parts of the vault.

1.7.6.2 Independent Power Sources. For an alternate independent power source to qualify as emergency power, it must be generated by a separate power generating station and be routed over separate power lines. In the past, careful investigation in the vast majority of cases has revealed that seemingly independent sources were so interconnected that failure of one power source could result in failure of the other. Extreme care shall be taken to assure qualification of the alternate power source before deciding against an engine/generator as an independent power source.

1.7.7 Airfield Lighting Control. The airfield lighting control system shall consist of control panels, relay equipment, accessories, and circuits

to energize, deenergize, select lamp brightness, and otherwise control various airfield lighting circuits in accordance with operational requirements.

Control of any one airfield lighting system shall normally be provided at only two points: the control tower and the vault which powers that system. Exceptions are Simulated Carrier Deck Lighting, which is controlled from the Landing Signal Officer (LSO) station only; Optical Landing System, which is controlled from the tower and/or LSO station; runway waveoff lights which are controlled from the LSO station, the wheels watch position, and the control tower; and wheels watch lights which are controlled from the wheels watch position. See Figure 1 for a typical lighting vault block diagram.

A transfer relay assembly is provided at the vault to transfer control from the remote location to the vault when necessary.

1.7.7.1 Control Voltages. A 120 Vac control system shall be provided using low burden pilot relays (pilot relay assemblies) to activate the power switches, contactors, and relays controlling the regulators and transformers supplying power to the airfield lighting circuits. For proper function of the pilot relay assemblies, the maximum one-way horizontal distance from the control tower to the lighting vault is limited to 7,350 ft (2,240.3 m) when using 120 Vac control systems. Where the distance between the tower and the vault exceeds the maximum, consideration should be given to using a 48 Vdc control system as described in FAA AC 150/5340-24, Runway and Taxiway Lighting Systems. Where both types of control systems are installed, care shall be taken to ensure isolation between the control power systems.

1.7.7.2 Control Circuitry. The control system shall be circuited to ensure the following:

a) Lighting on intersecting runways cannot be energized simultaneously.

b) All circuits supplying the lights for any one lighting system (for example, runway edge lighting) are energized simultaneously and are operated at the same brightness level.

c) Runway centerline lights may not be energized unless the runway edge lights are energized.

d) Touchdown Zone Lighting (TDZL) cannot be energized unless the runway centerline lights are energized.

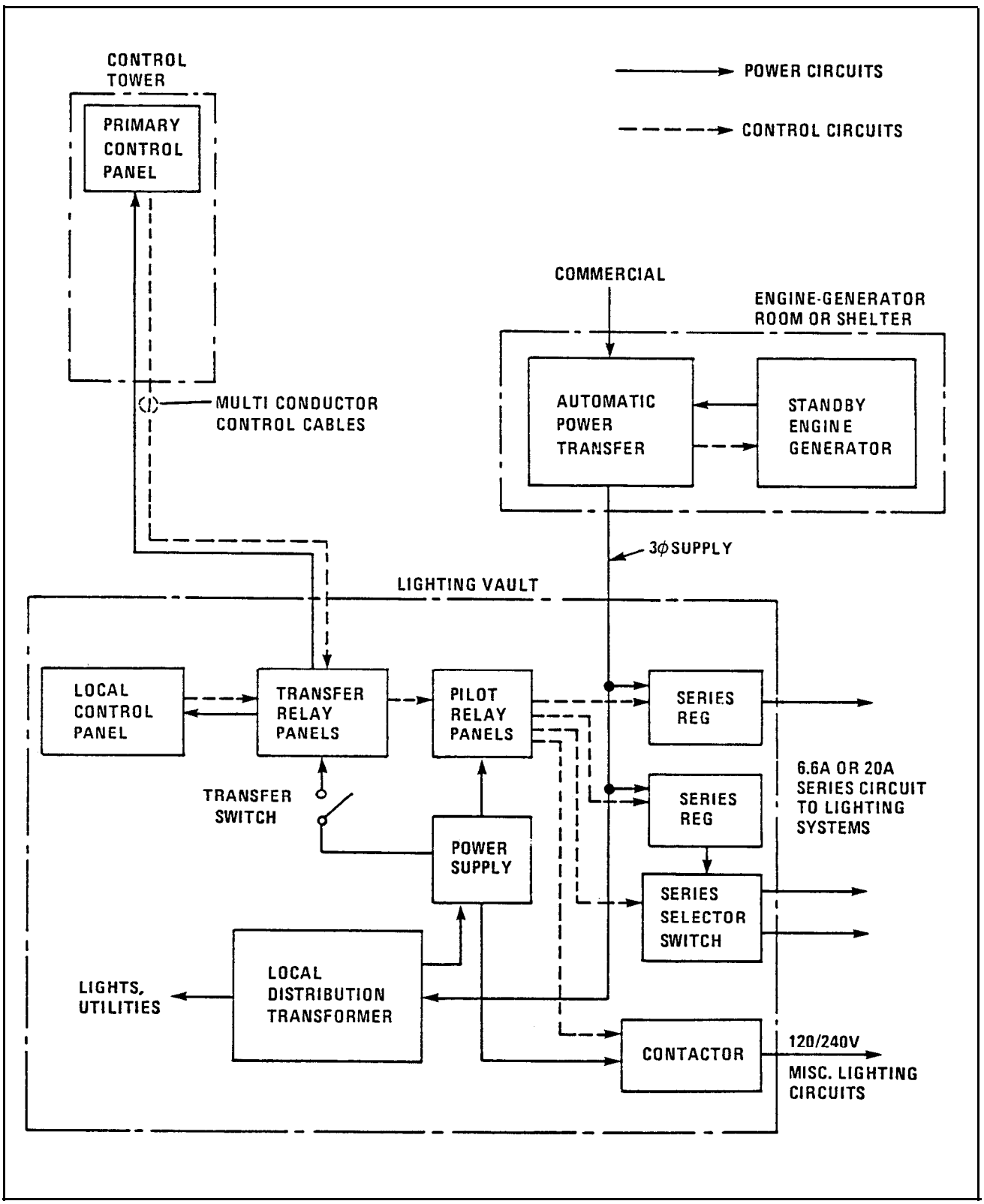


Figure 1
Control and Power System Block Diagram

1.7.8 Light Intensity. The brightness steps associated with five levels of lamp intensity, achieved by varying the current in the lighting circuit, are as follows:

Brightness Step	Amperage Reading 20 A Circuit	Amperage Reading 6.6 A Circuit	Approx. Percent Rated Intensity
1	8.5	2.8	0.16
2	10.3	3.4	0.8
3	12.4	4.1	4.0
4	15.8	5.2	20.0
5	20.0	6.6	100.0

The brightness steps associated with three levels of lamp intensity, achieved by varying the current in the lighting circuit, are as follows:

Brightness Level	Series Systems Lamp Current (amps)	Percent Brightness
High	6.6	100
Medium	5.5	30
Low	4.8	10

1.7.9 Light Colors. For colors of lights, refer to MIL-C-25050A, General Requirements for Color, Aeronautical Lights and Lighting Equipment.

1.8 Qualifying Equipment. This handbook identifies equipment and equipment specifications that meet the standards established for the various airfield lighting systems. It includes only those items that are peculiar to airfield lighting systems. Common use equipment and materials are covered in other handbooks.

1.8.1 Existing Systems. The equipment specified in this handbook is not necessarily suitable for mixing with older equipment fabricated to earlier standards. There shall be a general plan to support existing systems with equipment fabricated to the same specifications as the original equipment until the system is upgraded to the new standard, or until it is no longer feasible to do so because of lack of supply sources, or for other reasons. When it has been determined that combining of new generation equipment with older equipment is required, care shall be taken to assure that the difference in performance does not degrade the system in any way.

1.8.2 Equipment Specifications. The equipment specifications referenced in this section falls into three broad categories: Military Specifications (MIL Specs); FAA Advisory Circulars (AC), and FAA-E series specifications (FAA-E-XXXX). For many items of equipment, there will be two or more specifications for qualified equipment. The fact that a particular item has both a qualifying MIL-Spec and a qualifying AC does not necessarily mean that the items are identical in form, fit and function. For example, the light output of an elevated runway edge light manufactured in accordance with MIL-L-26202D, Light, Marker, Airport, Semiflush, Class B-3 may be quite different from a runway edge light manufactured in accordance with FAA AC 150/5345-46A, Specification for Runway and Taxiway Light Fixtures, L852E, even though they both meet the standards established for the system in NAVAIR

51-50AAA-2. It is recommended that users of this handbook assure themselves that the performance characteristics, particularly with respect to light output and aiming, are compatible before electing to combine military equipment with FAA type equipment of the same category (e.g., elevated runway edge lights) in a single runway, taxiway, or approach lighting system.

The specifications cited in this handbook are the current edition as of the date of this publication. The latest edition of the specification shall be used, provided that the performance requirements continue to satisfy the appropriate standard set forth in NAVAIR 51-50AAA-2. Where specifications are cancelled and replaced by successor specifications with new numbers, the successor specification may be used, provided the requirements of the applicable standards in NAVAIR 51-50AAA-2 continue to be met.

1.8.3 Qualified Products. Both the military and the FAA maintain lists of manufacturers of products conforming to Military Specifications or to AC specifications. For equipment conforming to military specifications, use the Qualified Products Listing (QPL) in the DOD Index of Specifications and Standards. For equipment conforming to FAA AC specifications, use FAA AC 150/5345-1, Approved Airport Lighting Equipment. Either listing may be used in the same manner and with equal effect. Qualification or approval in either listing does not mean automatic acceptance of the equipment for a particular project. Satisfactory evidence of the production tests specified by the specifications is required for acceptance for each project.

Sources for equipment manufactured to FAA-E series specifications are not covered by a qualified products list of any kind. Current sources of this equipment may be obtained, through channels, from the FAA. The specified production tests are also required for products obtained from these sources.

1.8.4 Commercial Equipment. Commercial equipment, not covered by appropriate military or FAA specifications, shall conform to applicable industry standards such as the recommendations of the National Electrical Manufacturers Association (NEMA), Institute of Electrical and Electronic Engineers (IEEE), etc. The contract specifications should provide the methods for verifying conformance.

1.8.5 Alternative Equipment. The specifications for many older types of equipment that fail to meet the standards of NAVAIR 51-50AAA-2 are not cited in this handbook. Some manufacturers have been producing equipment that exceeds the specification to meet the requirement of the current standard. The use of this equipment may be considered if there is sufficient documented evidence and warranty that the equipment does and will continue to meet the requirements of the standard.

Substitution of equipment, using new technology that is not covered by listed specifications, may be considered. However, precautions must be taken to assure that the system standards contained in this handbook and in NAVAIR 51-50AAA-2 will be met; that USN requirements for cost effectiveness, maintainability, reliability, availability, and service life will be met; and that adequate training and logistic support for the substitute equipment will be available.

1.8.6 Emergency Substitution. In emergency situations, where facility restoration is significantly delayed by nonavailability of replacement parts, equipment or devices not meeting specifications and standards may be substituted. Such substitute equipment shall be removed from service and replaced with approved equipment as soon as possible.

1.8.7 Common Use Airfield Lighting Equipment. The equipment described in paras. 1.9.7.1 through 1.9.7.13 is commonly used in most airfield lighting system installations. Wherever required, listed equipment conforming to the cited specifications may be used. Other special application equipment is referenced in the paragraphs covering the particular lighting system involved.

1.8.7.1 Control Panels. Control panels meeting the requirements of MIL-P-8944A, General Specifications for Airport Lighting Control Panel, or FAA AC 150/5345-3, Panels for Remote Control of Airport Lighting Systems, Type L-821, may be used. Tower cab design constraints or special air traffic controller requirements may dictate the use of other types of control panels.

1.8.7.2 Pilot Relay Cabinets. Pilot Relay Cabinets shall meet requirements of MIL-P-8945A, Panel, Relay, Pilot, Enclosed, Airport Lighting, when used in 120 Vac control systems and shall meet FAA AC 150/5345-13, Type L-841 when used in 48 Vdc control systems.

1.8.7.3 Series Circuit Selector Switches. Switches shall meetrequirements of FAA AC 150/5345-5A, Type L-874.

1.8.7.4 Control Transfer Panels. Control transfer panels shall meet requirements of MIL-P-4971A, Panel, Control Transfer. Airport Lighting Type MB-l.

1.8.7.5 Control Cables. Control cables for 120 Vac control systems shall be multiconductor, 600 V, 12 AWG, to meet FAA-AC 150/5345-7, L-824 Underground Electrical Cable for Airport Lighting Circuits, rated for direct earth burial. Cables for 48 Vdc control circuits shall be multiconductor, stranded 19 AWG, with 300 V polyvinyl insulation suitable for installation in wet locations and conforming to Rural Electrification Administration (REA) Bulletin 345-14 or 345-67, PE-23 for Telephone Cable for Direct Earth Burial and P-39 for Filled Telephone Cables respectively. All conductors shall be copper and insulation shall be color coded.

1.8.7.6 Current Regulators. Regulators shall meet requirements of FM AC 150/5345-10 of a suitable type and style. The size selected shall normally provide for approximately 20 percent future expansion.

1.8.7.7 Engine/Generators. Engine/generators shall meet requirements of MIL-G-19826 Generator Sets, Diesel Engine, Alernating Current, 10 kw through 500 kw with automatic transfer gear conforming to MIL-C-26885 (ASG) Cubical, Power Distribution Automatic Transfer, Airfield Lighting or FAA-E-2204 Diesel Engine Generator Sets, 5 kW to 300 kW with Type I automatic power transfer.

1.8.7.8 Lighting Circuit Cables. Lighting circuit power cables shall meet requirements of FAA AC 150/5345-7, for L-824 Type B or C, except that in saw kerf installations they may be Type THWN conforming to UL 83. The cable size and insulation rating of all cables shall be suitable for the application.

Cable shielding is required only where there are known or anticipated problems with intercircuit interference.

1.8.7.9 Connectors. Connectors meeting requirements of FAA AC 150/5345-26, L-823 Plug and Receptacle Cable Connectors, shall be used to interconnect fixtures, isolation transformers, and distribution cables.

1.8.7.10 Isolation Transformers. Isolation transformers meeting the requirements of either MIL-T-27535A, Transformer, Power, Isolation, Series Circuit, or FAA AC 150/5345-47, Isolation Transformers for Airport Lighting Systems, may be used. The principal difference between the two types of transformers is that the primary leads of the MIL type are 6 in. (152.3mm) longer than the FAA type. When specifying, assure that the input/output currents are compatible with the regulator and current rating of the lamp.

1.8.7.11 Mounting Bases and Transformer Housings. Mounting bases meeting the requirements of MIL-B-8954B, Base and Accessories, Airport Marker Lights, or FAA AC 150/5345-42, L-857, Airport Light Base and Transformer Housings, Junction Boxes and Accessories, may be used. When specifying FAA types bases, specify Type L-867 for nontraffic areas and Type L-868 for load bearing applications. Unless otherwise specified, nonmetallic bases may be used in nonload bearing applications. Care should be taken to assure that the base and the fixture are compatible.

1.8.7.12 Frangible Supports. Where frangible mounting is required and the device is not provided with an integral fracture mechanism, the device shall be mounted on Electric Metallic Tubing (EMT) or Intermediate Metallic Conduit (IMC) which is attached to the mounting base by means of a frangible coupling conforming to FAA Drawing C-6046A, Frangible coupling, Type 1 and 1A, Details.

1.8.7.13 Fixtures and Lamps. Fixtures and lamps shall be as specified for each system. Where the design calls for more than one fixture to be connected to an isolation transformer, the fixture shall be ordered with a shorting device or bypass relay to avoid multiple fixture outage in the event of a lamp failure.

1.9 Preparation of Contract Specifications. In preparation of contract specifications, the designer shall use Naval Facilities Engineering Command (NAVFAC) NFGS-01011, Additional General Paragraphs, and NFGS-16560, Airfield Lighting, for guidance on contract requirements and elements to be covered. Particular attention should be given to the inclusion of those appropriate paragraphs which are directed toward the orderly and safe execution of the contract with minimal impact of ongoing operations.

Section 2: APPROACH LIGHTING SYSTEMS

2.1 High Intensity Approach Lighting System (Cat. Code 136-10)

2.1.1 Description. The High Intensity Approach Lighting System (ALSF-1) is a high intensity Approach Lighting System (ALS) with sequenced flashers. It is the USN standard system for precision approaches to a Cat. I instrument runway.

2.1.2 Configuration. The ALSF-1 consists of a prethreshold bar, a terminating bar, a 1,000 ft (304.8 m) bar, centerline lights, sequenced flashers, and enhanced threshold lights. A typical standard layout is shown in Figure 2. The standard system centerline is coincident with the extended runway centerline. The system extends from the threshold 3,000 ft (914.4 m) into the approach area of the runway. NAVAIR approval is required for the installation of systems shorter than 3,000 ft. Shortening a system below 2,400 ft (731.5 m) can impact the landing minimums. Systems which are between 1,400 ft (426.7 m) and 2,300 ft (701 m) are called Short Approach Lighting Systems (SALS).

2.1.2.1 Prethreshold Bar. The prethreshold bar consists of two barrettes of red lights placed symmetrically about and perpendicular to the system center line at a point 100 ft (30.4 m) ahead of the runway threshold. Each barrette consists of five lights on 3.5 ft (1 m) centers with the innermost lights of each barrette located 75 ft (22.9 m) from the extended runway centerline.

2.1.2.2 Terminating Bar. The terminating bar consists of 2 barrettes of aviation red lights symmetrically disposed about and perpendicular to the system centerline 200 ft (61 m) ahead of the runway threshold. Each barrette consists of 3 red lights on 5 ft (1.5 m) centers with the inboard lights of each barrette placed 36 ft (11 m) from the extended runway centerline.

2.1.2.3 1,000-Ft Bar. The 1,000-ft bar consists of 2 barrettes of white lights placed symmetrically about and perpendicular to the system centerline at a point 1,000 ft from the runway threshold and in line with the centerline barrette located at that station. Each barrette consists of 8 white lights on 5 ft spacing with the outboard light located 50 ft (15.2 m) from the system centerline.

2.1.2.4 Centerline Lights. The centerline lights consist of a series of barrettes of white lights placed at 100-ft intervals along the system centerline from a point 100 ft from the runway threshold outward to a point 3,000 ft from the runway threshold. Each barrette consists of 5 white lights spaced by 3.5 ft (1 m) and is centered on and perpendicular to the system centerline. The spacing between lights may be reduced to 40.5 in. (1,028 mm) to facilitate installation on Low-Impact-Resistant (LIR) supports.

2.1.2.5 Sequenced Flashing Lights. The sequenced flashing lights consist of a series of flashing lights placed on the system centerline at each centerline light station from the 1,000-ft (304.8 m) bar to the outer end of the approach light system. The lights flash bluish white light at a rate of twice per second in sequence from the outermost light inward so as to appear as a ball of white light traveling toward the runway threshold. Sequenced flashing

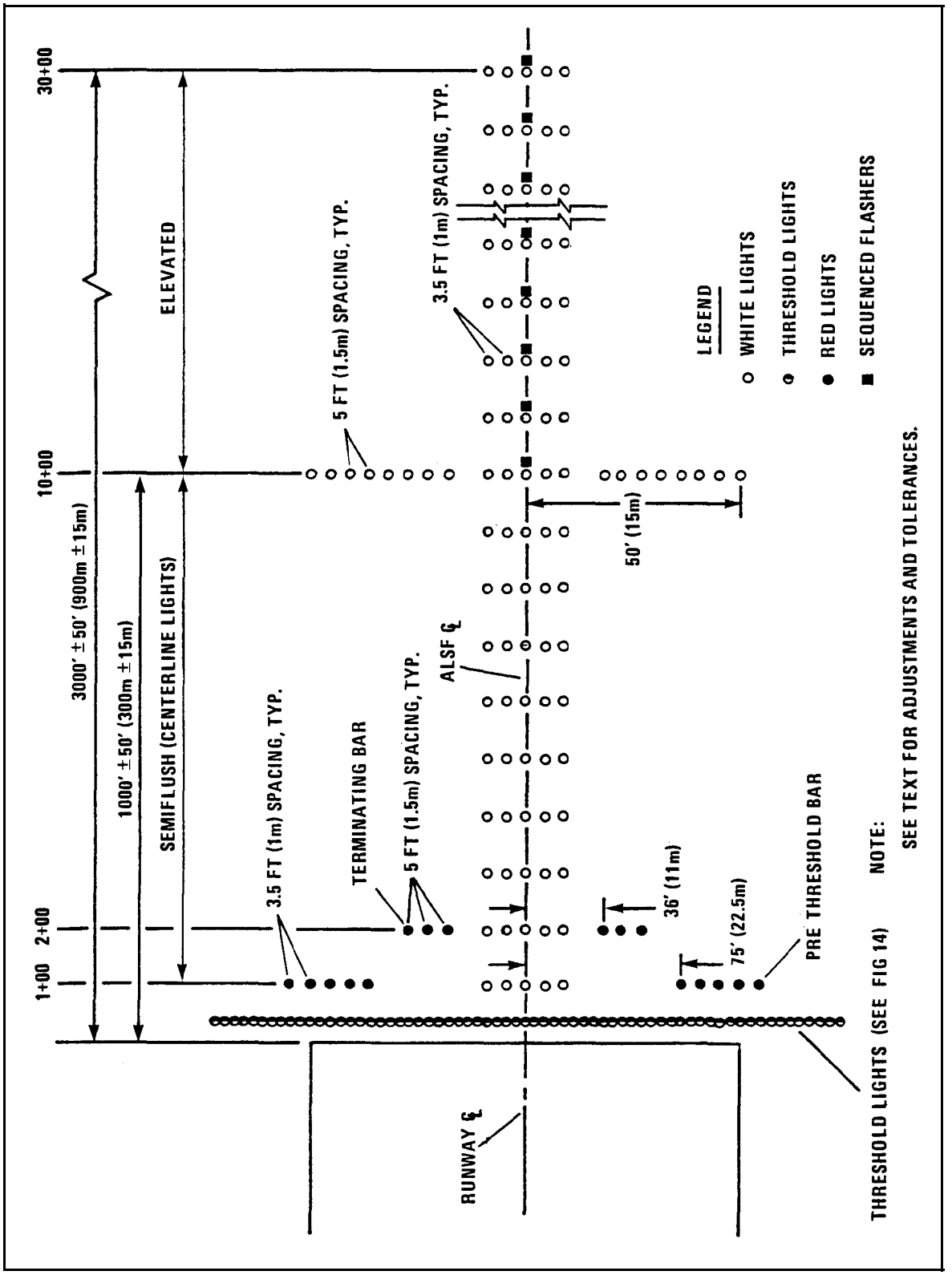


Figure 2
Typical ALSF-1 Configuration

lights may be uniformly mounted a maximum of 4 ft (1.2 m) below the center steady burning light. In the case of semiflush units, they may be displaced a maximum of 5 ft (1.5 m) into the approach along the extended runway centerline in order to avoid visual or physical interference between light units.

2.1.2.6 Threshold Lighting. While technically not considered part of the ALS, standard runway threshold lighting shall be enhanced as indicated in para. 3.2.3 when high intensity approach lights are installed.

2.1.3 Fixtures. All approved light fixtures installed in displaced threshold areas, or where they are subject to damage by jet blast, shall be of the semiflush type with no part of the unit extending more than 1 in. (25.4 mm) above the surrounding pavement. In overruns, centerline barrettes are to be semiflush and all other lights are elevated fixtures. All other lights fixtures will be elevated and capable of being aimed.

All lights in the system are aimed toward the approach, parallel to the extended runway centerline in the horizontal plane. Except for sequenced flashers, which are aimed at +6°, and semiflush fixtures which have fixed aiming, the approach lights shall be vertically aimed as follows:

STATION FROM	STATION TO	AIMING ANGLE
1+00	2+00	6.0°
3+00	10+00	6.5°
11+00	18+00	7.0°
19+00	26+00	7.5°
27+00	30+00	8.0°

Note: Each 1+00 station is equivalent to 100 ft (30.4 m).

If the electronic glide slope angle is other than 3°, the aiming of the lights shall be adjusted by the amount of the difference from 3° and in the direction of the change.

2.1.4 Supports. Elevated fixtures shall be supported on frangible, low-impact-resistant, or semifrangible supports, depending on the required mounting height.

2.1.4.1 Frangible Supports. Frangible supports shall be used to mount lights up to 6 ft (1.83 m) above the ground. They consist of EMT or IMC mounted on frangible couplings.

2.1.4.2 LIR Supports. LIR supports shall be used to support lights mounted 6 to 40 ft (1.8 to 12.2 m) high. LIR supports are designed to present a minimum of mass and to break when impacted.

2.1.4.3 Semifrangible Supports. Semifrangible supports shall be used to support lights mounted more than 40 ft above the ground. They are two-element structures; the lower element being a rigid structure and the upper element being a 20-ft (6 m), LIR structure.

2.1.5 Approach Light Plane. The approach light plane is an area 400 ft (121.9 m) wide centered on the extended runway centerline which begins at the runway threshold and extends 200 ft (60.96 m) beyond the outermost lights. Ideally all approach lights will be installed in a single horizontal plane at the same elevation as the threshold with no penetrations of the light plane. This should be achieved wherever possible and practical. Where site conditions dictate, the criteria given in paras. 2.1.5.1 and 2.1.5.2.

2.1.5.1 Light Plane Penetrations. No penetration of the light plane shall be permitted except for ILS components and components of airfield lighting systems which are fixed by their function. These components should not interfere with the pilot's view of the approach lights when on a normal approach and shall be obstruction lighted. For clearance purposes, all roads, vehicle parking areas and railroads are considered as vertical solid objects. The required clearance above Interstate highways is 17 ft (5.18 m). The clearance required above other public roads and parking lots is 15 ft (4.57 m), and for railroads 23 ft (7.0 m). The clearance above private and military roads is 10 ft (3.05 m). Airfield service roads, where traffic is controlled, are not considered as obstructions. Control of the service road traffic may be accomplished by appropriate signs or directly by the control tower. The means of control and the wording of signs shall be as approved by the Airfield Commander.

2.1.5.2 Light Plane Adjustments. When installed in displaced thresholds or in prepared overruns the plane of the approach lights follows the contour of the ground. Outside these areas, elevated light fixtures will be installed in a plane as level as possible. Where necessary, a portion of the light plane may be sloped upward a maximum of 2 percent or downward a maximum of 1 percent if necessary to avoid penetration of the light plane or for reasons of economy. The sloping segment may commence no closer than 300 ft (91.4 m) from the runway threshold and shall contain a minimum of four light stations. The sloping segment may continue to the end of the system or may revert to a horizontal plane containing a minimum of three light stations. No negative slopes are permitted in the inner 1,500 ft (457.2 m) of the system except those generated by the slope of the overrun. The system may contain no more than one sloping segment in addition to those generated by the overrun.

2.1.6 Visibility Requirements. There shall be a clear line of sight to all lights in the system from any point on a surface 100 ft (30.5 m) below the glide path and extending 250 ft (76.2 m) each side of the centerline, at 4,500 ft (1,371.6 m) from the runway threshold. Unless otherwise defined, the glide path angle may be assumed to be 3°.

2.1.7 Configuration Adjustments. Siting considerations may dictate that the configuration of the approach light system will require adjustment. The following adjustments described in paras. 2.1.7.1 through 2.1.7.2 are permissible without seeking a waiver.

2.1.7.1 System Centerline. The light system centerline may be laterally displaced from the extended runway centerline a maximum of 2 ft (0.6 m) to align the system centerline with a runway centerline lighting system.

2.1.7.2 Light Station Locations. To avoid roads, buildings, railroads etc. it may be necessary to move a light bar longitudinally away from its nominal location. Where this is necessary, the light bar spacings shall be changed

to uniformly distribute the differences so that the spacing between adjacent light stations shall be kept at 100 ft ±10 ft (30.5 m ±3 m) and system length is maintained.

2.1.8 Installation Tolerances. Permissable installation deviations from the design locations are as follows:

a) Light stations shall be installed within 6 in. (152.4 mm) of the designated location.

b) The lateral tolerance for installation of a light bar is ±3 in. (±76.2 mm).

c) The tolerance or distance between individual lights is ±1 in. (±25.4 mm).

d) Mounting heights tolerances are in accordance with the following table:

SUPPORT HEIGHT	TOLERANCES
0 to 6 ft (0-1.8 m)	1 in. (25.4 mm)
6+ to 40 ft (1.8-12 m)	2 in. (50.8 mm)
to 40+ ft (12+ m)	3 in. (76.2 mm)

e) Deviation from a line perpendicular to the ALS centerline is ± 1 in. (25.4 mm).

f) Vertical angular alignment of a light shall be within 1°.

g) Horizontal angular alignment of light shall be within 5°.

2.1.9 Electrical Requirements

2.1.9.1 Substation. The ALS shall contain a main and a standby power system with automatic changeover within 15 seconds of a failure of the power system in use. Neither the power and control substation nor the standby power unit may be located within the area of the approach light plane.

2.1.9.2 Power Requirements. The substation shall provide 20 A regulated electric power to the steady burning lights and 120/240 V power to the sequenced flasher system (see Figure 3 for a typical block diagram). Historically the steady burning lights have been 20 A lamps at 300 W or more. It is now possible to meet the photometric requirements for the white lights in the system using lamps with wattages below 300 W. These lower wattage lamps are rated 6.6 A and require 20A/6.6 A isolation transformers. The decision on which light to use has an additional impact in those situations where fixtures are being installed on LIR supports. Where 20 A lamps are used, all the lamps are connected in series to a single 1,500 W transformer. Each fixture is provided with a shorting device which bypasses the fixture when the lamp bums out. This was designed to reduce the number of conductors exposed to impact forces. If the lower wattage lamps are used, this design approach is not practical because 20 A/6.6 A Transformer of sufficient wattage

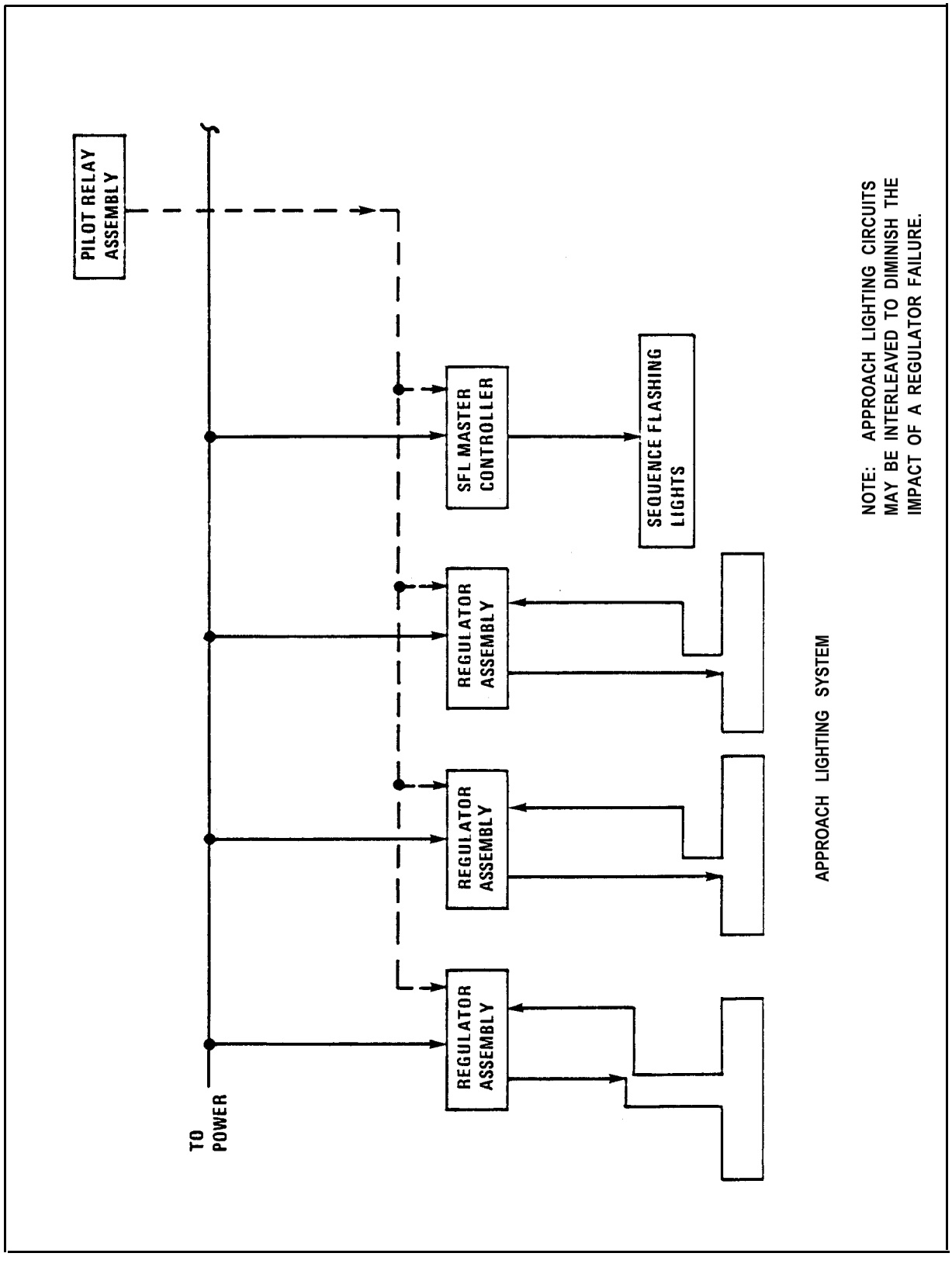


Figure 3
Block Diagram of Approach Light Circuits

to handle the load are not available. It will be necessary to wire the fixtures conventionally to individual transformers.

2.1.10. Control Requirements. Remote system control is required for turning the ALS on or off and for providing five-step intensity control for the steady burning lights and three-step intensity control for the sequenced flashers. The sequenced flashing lights shall be coupled to the approach light controls to provide brightness levels paired with the steady burning lights as shown below. Flashing lights shall be capable of being switched off independently of the steady burning lights and shall not be operable unless the steady burning lights are energized.

STEADY BURNING INTENSITY STEP	FLASHER INTENSITY STEP
Off	Off
1 or 2	low (2.3 percent)
3	medium (10 percent)
4 or 5	high (100 percent)

2.1.11 Monitoring. Monitoring of ALS performance is not required but may be included by specifying equipment that provides monitoring features. Monitoring may also include a feature which causes an alarm to be sounded in the control tower after the approach lights have been operating on brightness Step 5 for a predetermined period. The alarm should be adjustable from 15 to 30 minutes. An alarm silencing switch shall be provided.

2.1.12 Equipment Requirements. Equipment meeting the specifications given in paras. 2.1.12.1 through 2.1.12.11 will satisfy the requirements for high-intensity ALS.

2.1.12.1 Semiflush Fixtures (White). Fixtures conforming to FAA AC 150/5345-46, Type, L-850E without filters may be used. When ordering, specify the photometric requirements (see Figure 4). Lamps shall be as recommended by the manufacturer to meet the requirement. Several manufacturers may meet the requirement using different lamps. In the interest of energy conservation the use of lower wattage lamps is preferred.

2.1.12.2 Elevated Fixtures. Fixtures conforming to FAA-E-982G, PAR-56 Lamp Holder, without bypass relay may be used with PAR-56 lamps that meet the photometric requirements of Figure 4.

2.1.12.3 Elevated Fixtures Over 6 Ft Above Ground Level (AGL). Fixtures conforming to FAA-E-982G with bypass relay may be used with 300 W, 20 A Q20A/PAR-56 lamp where it has the frangibility required of the system.

2.1.12.4 Light Fixture Supports 0 to 6 Ft AGL. Elevated light fixtures mounted 0 to 6 ft (0 to 2 m) AGL are mounted on 2 in. (50 mm) diameter. EMT which is fitted at the bottom with a frangible coupling conforming to FAA Drawing C-6046A, Frangible Coupling, Type 1 and Type 1A, Details.

2.1.12.5 Light Fixture Supports Over 6 Ft AGL. Light fixtures elevated between 6 ft (1.8 m) and 40 ft (12.1 m) AGL are supported on

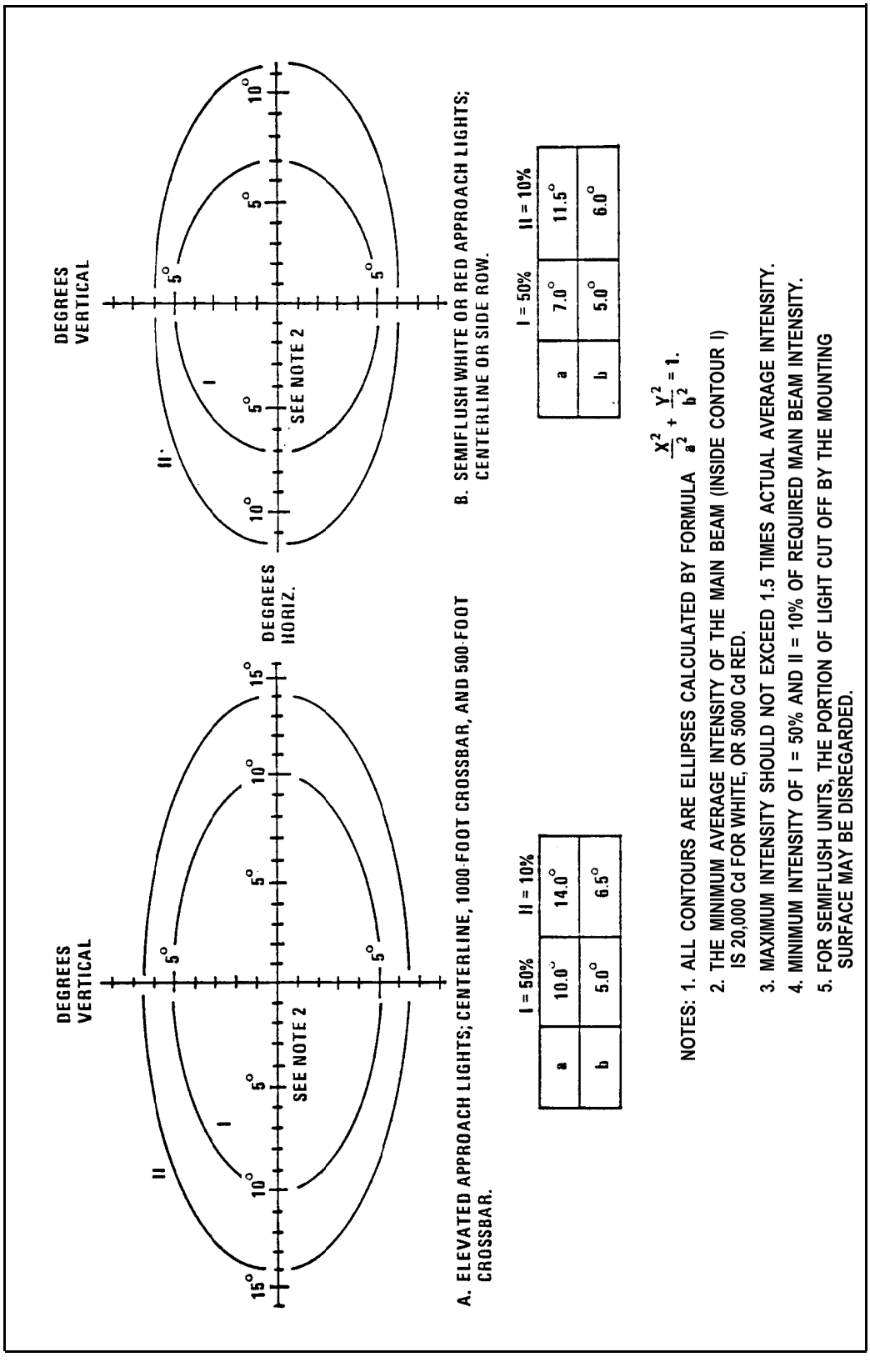


Figure 4
Photometric Requirements for High Intensity Approach Lighting Systems

approach light support towers conforming to FAA-E-2702 and FAA Drawing Series D-6155, ALSF-2, 6′ to 128′ and MALS 40′ to 128′, LIR Structures. Light fixtures elevated more than 40 ft AGL are supported on 20-ft (6.09 m) telescoping masts conforming to FAA-E-2702, Low Impact Resistant Structures, and FAA Drawing Series D-6155 which are installed on rigid supports.

2.1.12.6 Rigid Supports for Fixtures over 40 Ft AGL. Structural steel supports fabricated in accordance with FAA-E-910G, Structural Steel, and FAA Drawing Series D-6076 may be used to support the 20-ft telescoping light supports.

2.1.12.7 Isolation Transformers (1,500 W). Isolation Transformers for fixtures elevated more than 6 ft AGL are 1,500 W, 20A conforming to FAA-E-2690, Isolation Transformer for Approach Lighting, when used with fixtures wired in series to a single transformer.

2.1.12.8 Sequenced Flasher Units. Sequenced flashers are system oriented and must be selected with care to assure satisfactory service. The power and control shall be compatible with the associated ALS equipment. All elevated flasher units are “remote head units” with the flasher head mounted atop a support and the unit power and control equipment installed at grade, or in the case of very tall supports, on a service platform.

When retrofitting existing systems, flasher units conforming to FAA-E-2325D, Medium-Intensity Approach Light System with Runway Alignment Indicator Lights, may be installed and operated with existing flasher system controls; however, the existing controls will not take advantage of the three intensity operational capability of the flasher unit. Should brightness control be required in a system upgrading, a flasher system control conforming to FAA-E-2325D is compatible with existing ALS control systems and provides brightness control. Modification may be required to provide for al-flasher operation instead of the five specified for the control.

Flasher systems conforming to FAA-E-2628B, Sequenced Flashing Lighting System, Elevated and Semiflush with Dimming and Monitoring, or FAA-E-2689A, Dual Mode High Intensity Approach Lighting System (ALSF-2/SSASR), have all the required control features, and also have sophisticated monitoring features, but the controls are solid state and require special interfacing with the ALS controls. Flasher units built to these specifications may be capacitive discharge type or of a type known as Line Current Discharge (LCD) which requires different field wiring.

2.1.12.9 Semiflush Sequenced Flasher Units. Where required, in displaced thresholds, fixtures conforming to FAA-E-2628B installed in a base conforming to FAA-E-1315A, Light Base and Transformer Housing, will satisfy the standard. Caution must be taken to assure electrical compatibility with the flasher system.

2.1.12.10 Approach Light Power and Control. Equipment conforming to FAA-E-2689A shall be used for all new installations and installations being fully upgraded to present standards. Controls conforming to this specification employ digital logic and telephone type control lines and control voltages.

2.1.12.11 Additional Design Guidance. Although some of the publications listed in paras. 2.1.13.1 through 2.1.13.3 are not in complete agreement with this handbook, they do contain significant information to assist in the development of ALSF-1 system plans and specifications. If a conflict exists, the requirements of this handbook shall take precedence.

2.1.13 NAVFAC P-272 Definitive Design Drawings

1404275	Approach Lighting System, Plan Layout, Elevation/Aiming Plan, Visibility Plan
1404276	Approach Lighting system, Approach Lighting Vault, One Line and Block Diagram
1404277	Approach Lighting System, Series Wiring, Fixture Schedule, Circuit Load Schedule
1404278	Approach Lighting System, SFL Wiring Diagram & Substation
1404279	Approach Lighting System, Threshold, 500 Ft & Wing Bars Road Sections
1404280	Approach Lighting System, Terminating, 1000 Foot Cross and Centerline Bars
1404281	Approach Lighting System, Light Bar Sections, Tower & Miscellaneous Details

2.1.13.1 FAA Specifications and Drawings

FAA-C-2722	Construction of a High Intensity Approach Lighting System with Sequence Flashing Light for Category II (ALSF-2) Runways
FM Drawing D-6131	High Intensity Approach Lighting System with Sequenced Series Flashing Lights (ALSF-2)

These specifications and drawings cover FAA standards for installation of an ALSF-2 which is switchable to a Simplified Short Approached Light System (SSALR) mode. They can be adapted for installation of UNS standard ALSF-1 and ALSF-2 systems.

2.1.13.2 Guide Specifications

NFGS 16560	Guide Specification for Airfield Lighting

2.1.14 Compliance with International Military Standards

2.1.14.1 ASCC -This standard meets the Type B approach light system in ASCC Air Standard 65/4, Airfield Approach Lighting.

2.1.14.2 NATO -This standard meets or exceeds the hardware requirements for an approach lighting system built to NATO Standards. As of the date of this publication, the configuration does not meet the NATO standard. It will meet the standard of Edition 7 of STANAG 3316, Airfield Lighting, when issued. For the NATO configuration, use STANAG 3316.

2.2 High-Intensity Approach Lighting (ALSF-2)

2.2.1 Description. The ALSF-2 is a high-intensity approach lighting system that is intended for use where operation during Cat. II or lower weather minimums is required.

2.2.2 Configuration. The ALSF-2 illustrated in Figure 5 is configured as an ALSF-1 and has been modified as follows:

a) The red side barrettes at the prethreshold and terminating bars are removed.

b) A 500-ft (152.4 m) bar is added consisting of 2 barrettes of white lights placed symmetrically about and perpendicular to the system centerline in line with the centerline barrette at that station. Each barrette consists of 4 white lights on 5-ft (1.5 m) centers in the space centered between the centerline lights and side row lights.

c) Side row lights are added to the inner 9-light stations. These side rows consist of barrettes of 3 red lights placed symmetrically about and perpendicular to the system centerline at each of the inner 9-light stations. The lights in each barrette are on 5-ft centers and the inboard lights are 36 ft (10.98 m) from the extended runway centerline.

d) Threshold lights, while technically not part of the UNS ALSF-2 system, are modified as described in para. 3.2.3.2.

2.2.3 Other Design Considerations. All other design considerations are as described in para. 2.1 for ALSF-1, except that the transfer time between power sources is reduced to 1 second during periods of Cat. II operations (refer to para. 1.9.6.1 for further information).

2.2.4 Compliance with International Military Standards.

2.2.4.1 ASCC. This standard meets the requirements for a Type C approach light system as described in ASCC Air Standard 65/4, Airfield Approach Lighting.

2.2.4.2 NATO. This standard has no equivalent in the current issue of NATO STANAG 3316, Airfield Lighting. It will meet the NATO standards for Cat. II lighting when the Edition 7 of NATO STANAG 3316, Airfield Lighting, is published.

2.3 Medium-Intensity Approach Lights (MALSR) (Cat, Code 136-10)

2.3.1 Description. The MALSR is a medium-intensity approach light system with runway alignment indicator lights. It is intended for installation at USN airfields only in support of VFR or nonprecision instrument approaches where installation costs are a factor.

2.3.2 Configuration. The standard system consists of centerline lights, a 1,000 ft (304.8 m) crossbar, and sequenced flashing lights. The centerline is coincident with the extended runway centerline (see Figure 6). The overall system is 2,400 ft (731.52 m) long, but may be shortened to as little as 1,400

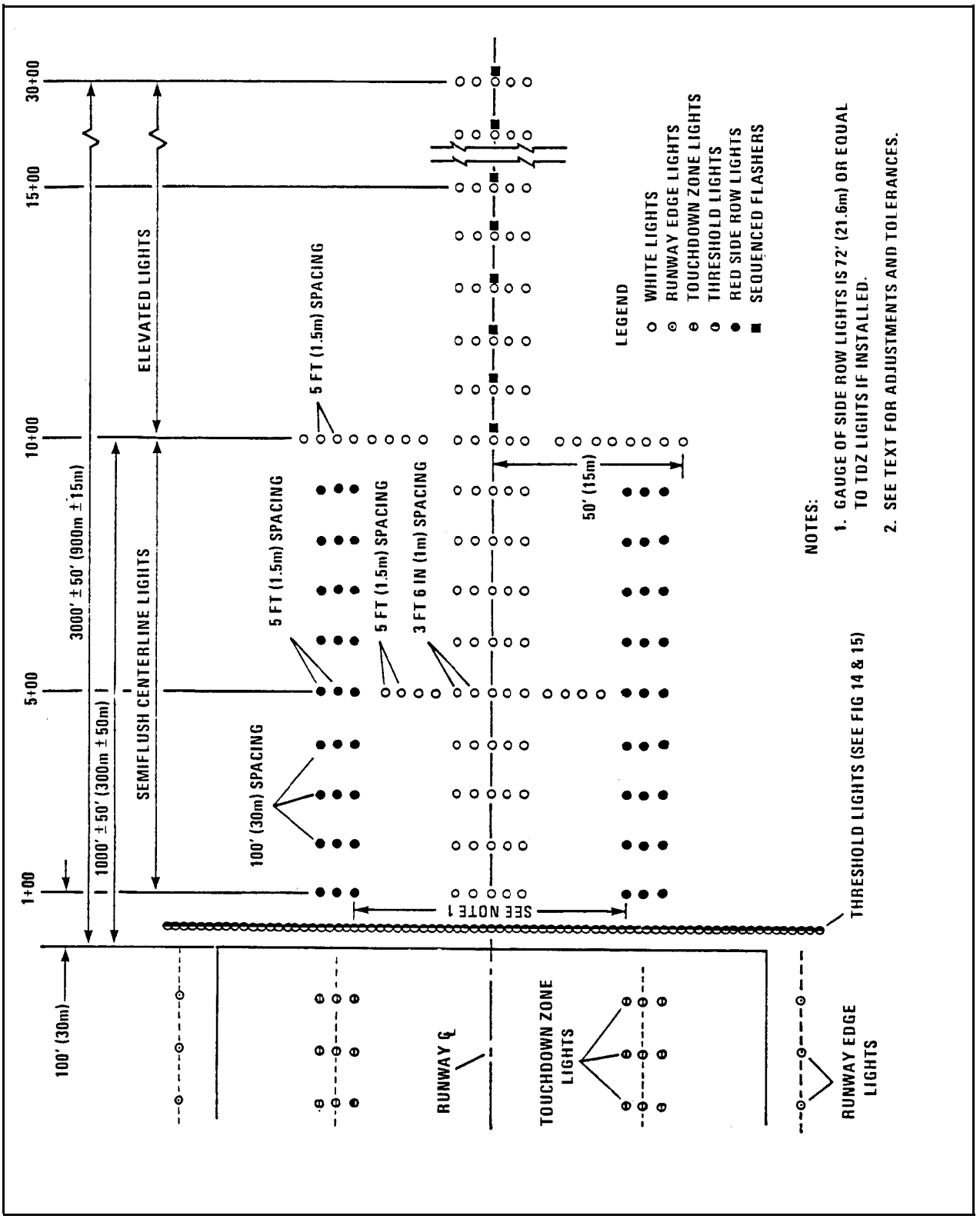


Figure 5
Typical ALSF-2 Configuration

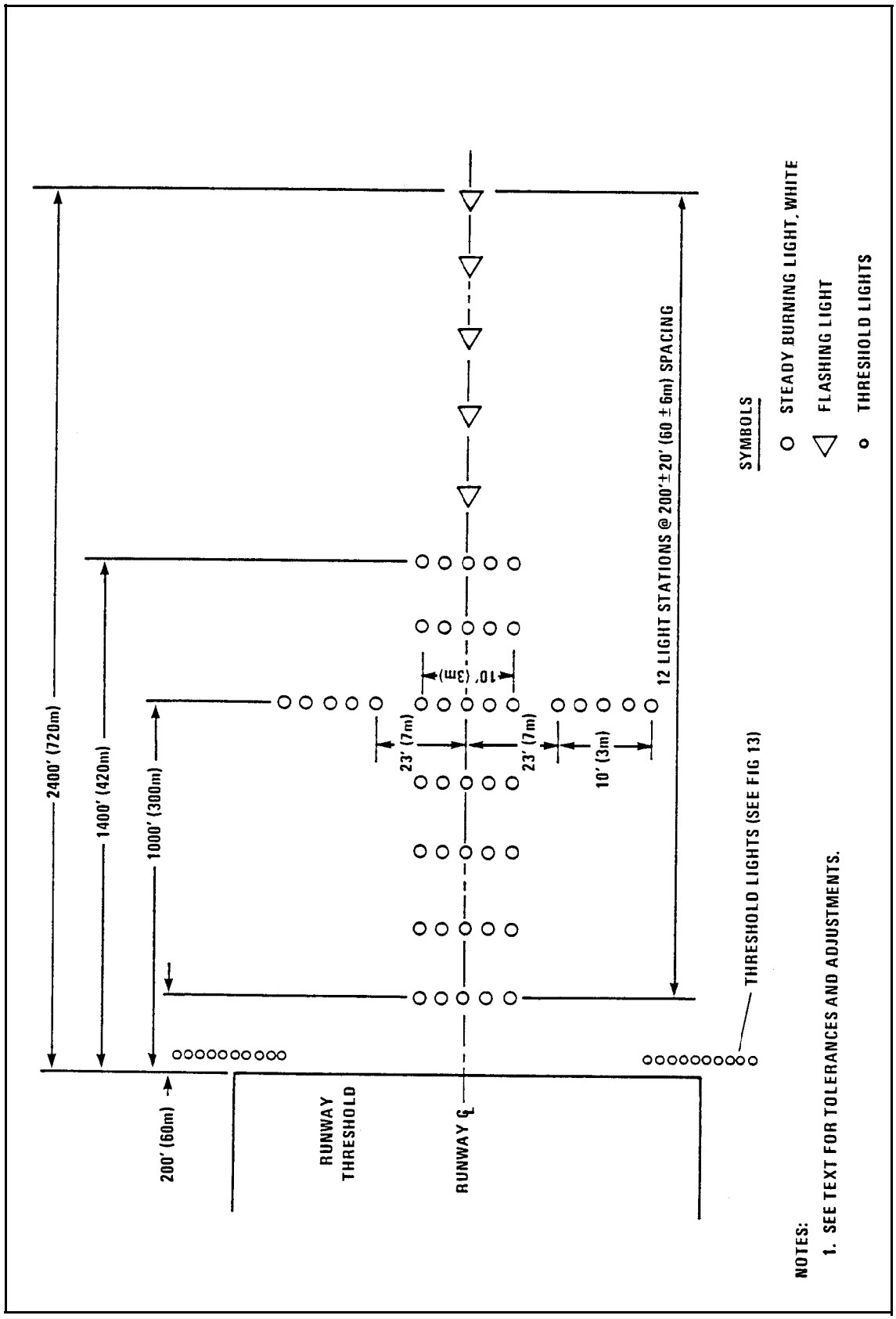


Figure 6
Typical MALSR Configuration

ft (426.7 m) where space or construction problems arise. Where systems are shortened to less than 2,000 ft (609.6 m) flashers will be added to steady burning light stations to provide a minimum of three flashing lights.

2.3.2.1 Centerline Lights. Commencing at a point 200 ft (60.96 m) from the threshold, centerline light barrettes shall be installed at 200 ft intervals to a point 1,400 ft from the threshold. Each barrette consist of five white steady burning lights installed on 2.5-ft (0.76 m) centers.

2.3.2.2 1000-Foot Crossbar. The 1000-ft crossbar shall be installed 1,000 ft (304.8 m) from the threshold. It shall consist of two side barrettes symmetrically placed about the extended runway centerline, in line with the centerline barrette. Each side barrette shall be composed of five white steady burning lights spaced 2.5 ft apart. The innermost light of each side barrette is 23 ft (97 m) from the system centerline.

2.3.2.3 Sequenced Flashing Lights. Sequenced flashing lights shall be installed on the system centerline at 200 ft (61 m) intervals commencing at a point 1,600 ft (487.7 m) and ending 2,400 ft (731.5 m) from the threshold. These lights flash bluish white light at a rate of 2 flashes per second. They are flashed in sequence so as to appear as a ball of light moving toward the runway threshold.

2.3.2.4 Threshold Lighting. While threshold lights are not considered part of the system, the runway shall be provided with threshold lights in accordance with para. 3.2.2.

2.3.3 Fixtures. Fixtures installed in displaced threshold areas shall be of the semiflush type with no part of the unit extending more than 1 in. (25 mm) above the surrounding pavement. All other light fixtures including those in overruns will be elevated and capable of being aimed. All lights in the system are aimed toward the approach, parallel to the extended runway centerline in the horizontal plane. Sequence flashing lights shall be aimed vertically at an angle of +6°. Semiflush fixtures have fixed aiming. Elevated fixtures are to be aimed as follows:

Station	Setting Angle above Horizontal (Degrees)	Station	Setting Angle above Horizontal (Degrees)
14+00	3.5	6+00	3.5
12+00	3.5	4+00	3.5
10+00	3.5	2+00	3.0
8+00	3.5		

Note: Each 1+00 station is equivalent to 100 ft (30.5 m).

2.3.4 Supports. Elevated fixtures shall be supported on frangible, LIR, or semifrangible supports, depending on the required mounting height.

2.3.4.1 Frangible Supports. Frangible supports shall be used to mount lights up to 6 ft (1.8 m) above the ground. They consist of EMT or IMC mounted on frangible couplings.

2.3.4.2 LIR Supports. LIR supports shall be used to support lights mounted 6 ft to 40 ft (1.8 m to 12.2 m) high. LIR supports shall be designed to present a minimum of mass and to break when impacted. For MALSR installation, these supports shall be lightweight aluminum tubing held together by friction fittings.

2.3.4.3 Semifrangible Support. Semifrangible supports are used to support lights mounted more than 40 ft (12.2 m) above the ground. They are two-element structures; the lower element being a rigid structure and the upper element being a 20 ft (6.1 m) LIR.

2.3.5 Approach Light Plane. The approach light plane is an area 400 ft (121.9 m) wide centered on the system centerline which begins at the runway threshold and extends 200 ft (60.4 m) beyond the outermost light. Ideally all approach lights will be installed in a single horizontal plane at the same elevation as the threshold with no penetrations of the light plane. This should be achieved wherever possible and practical. Where site conditions dictate otherwise, the information in paras. 2.3.5.1 and 2.3.5.2 shall be applied.

2.3.5.1 Light Plane Penetrations. No penetration of the light plane shall be permitted except for ILS components and the MALSR distribution panels which are fixed by their function. These components should not interfere with the pilot’s view of the approach lights when on a normal approach. For clearance purposes, all roads, vehicle parking areas and railroads are considered as vertical solid objects. The clearance above Interstate highways is 17 ft (5.2 m). The clearance required above other public roads and parking lots is 17 ft, and for railroads is 25 ft (7.62 m). The clearance above private or military roads is 10 ft (3.05 m). Airfield service roads where traffic is controlled are not considered as obstructions. Control of the service road traffic may be accomplished by appropriate signs or directly by the control tower. The means of control and the wording of signs shall be as approved by the Airfield Commander.

2.3.5.2 Permissable Deviations. Approach lights in displaced threshold areas will be semiflush and follow the contour of the pavement. Approach lights installed in the overrun will be elevated and frangibly mounted not more than 14 in. (355.6 mm) above the ground except that where the overrun has not been graded to the requirements of DM-21.01 the lights after station 2+00 through station 8+00 may be elevated to a maximum of 6 ft (1.83 m) to establish a uniform light plane which is within ±1 percent of horizontal. Commencing at station 8+00 through station 14+00 the light plane shall have a uniform slope not greater than two percent positive or one percent negative. Commencing at station 14+00 the plane through the sequenced flashers may have a maximum permissable slope of two percent positive and 2-1/2 percent negative. The plane of the flashers may have one change in gradient to include a minimum of three stations.

2.3.6 Visibility Requirements. There shall be a clear line of sight to all lights in the system from any point on a surface 0.5° below the glide path and extending 250 ft (75.2 m) each side of the centerline, for up to 1,600 ft (487.7 m) beyond the outermost light of the system. Unless otherwise defined, the glide path angle may be assumed to be 3°.

2.3.7 Configuration Adjustments. siting considerations may dictate that the configuration of the approach light system will require adjustment. The adjustments indicated in paras. 2.3.7.1 and 2.3.7.2 are permissable without seeking a waiver.

2.3.7.1 System Centerline. The system centerline may be laterally displaced from the extended runway centerline a maximum of 2 ft (0.6 m).

2.3.7.2 Light Station Locations. To avoid roads, buildings, railroads etc. it may be necessary to move a light bar longitudinally away from its nominal location. Where this is necessary the light bar spacings should be changed to uniformly distribute the difference so that the spacing between adjacent light stations shall be kept at 200 ft ± 20 ft (60 m ± 6 m) and overall system length is maintained.

2.3.8 Installation Tolerances. Permissable installation deviations from the design locations are as follows:

a) Light stations shall be installed within 6 in. (152.4 mm) of the designated location.

b) The lateral tolerance for installation of a light bar is ±3 in. (76.2 mm).

c) The tolerance or distance between individual lights in a barrette is ± 1 in. (25 mm).

d) Mounting height tolerances are in accordance with the following table :

SUPPORT HEIGHT	TOLERANCES
0 - 6 ft (0-1.8 m)	1 in. (25.4 mm)
6+- 40 ft (1.8-12.2 m)	2 in. (50.8 mm)
40+ ft (12.2+ m)	3 in. (76.2 mm)

e) Deviation from a line perpendicular to the ALS centerline is ± 1 in. (25.4 mm).

f) Vertical angular alignment of a light will be within 1°.

g) Horizontal angular alignment of a light will be within 5°.

2.3.9 Electrical design. Unlike most other airfield lighting systems the MALSR is a voltage controlled system wired in multiple (parallel). Single phase 120/240 V power is furnished to the steady burning lights at maximum intensity. Single phase power 120/240 V is required for the sequenced flashing light system. MALSR power and control equipment shall have weatherproof enclosures and be suitable for exterior installation (see Figure 7 for a typical functional relationship of a MALSR system).

2.3.10 Controls. The MALSR is to be provided with remote and local on/off and 3-step brightness controls. On/off and intensity controls for the sequence flashers will be coupled to the control of the steady burning

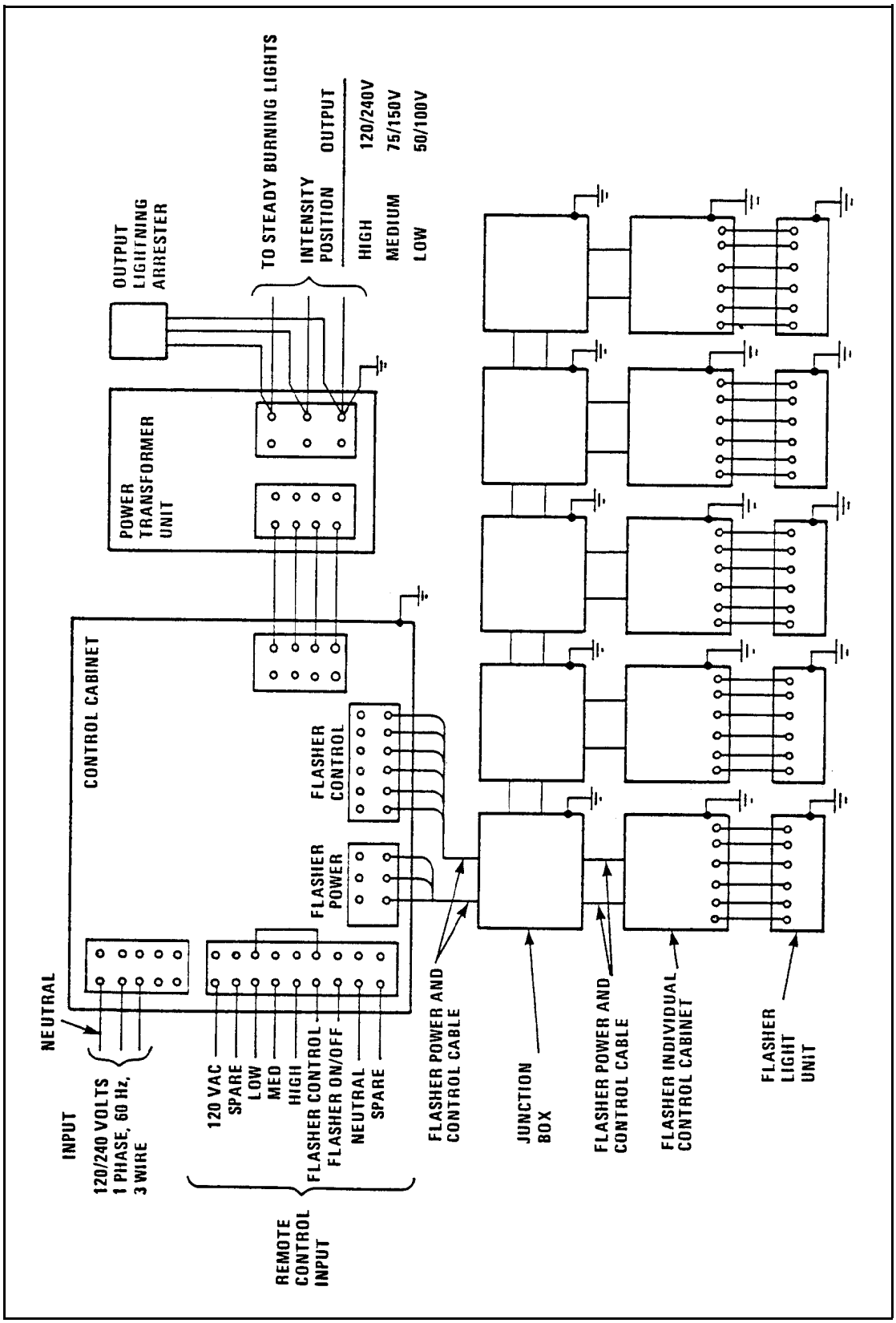


Figure 7
Functional Relationship of Units MALSR

lights. The sequence flashers shall be capable of being switched off independently of the steady burning lights and may not be operated unless the steady burning lights are energized. The brightness steps for the system are as follows:

FLASHERS INTENSITY STEP	STEADY BURNING VOLTAGE SETTING	ILLUMINATION LIGHTS PERCENT	SEQUENCE ILLUMINATION PERCENT
High	120/240 V	100	100
Medium	75/150 V	20	10
Low	50/100 V	4	2.3
		OFF	OFF

2.3.11 Equipment Requirements

2.3.11.1 Semiflush Fixtures. Fixtures conforming to FAA AC 150/5345-46, Type L-850B, with no filter may be used where semiflush fixtures are required. The fixture shall be specified without toe-in. These fixtures are used with a 200 W lamp designed for current regulated systems and require a special 240 V/30.3 V, 200 W transformer which is to be provided by the fixture manufacturer. These fixtures and transformer may be mounted in bases conforming to FAA AC 150/5345-42B.

2.3.11.2 Elevated Fixtures. Fixtures specified in FAA-E-2325D may be used for elevated fixtures. Lamps may be either 120 V 150 W PAR-38, 150PAR/SP or 120 V 120 W PAR-38, 150 PAR/SP meeting the photometric requirements given in Figure 8.

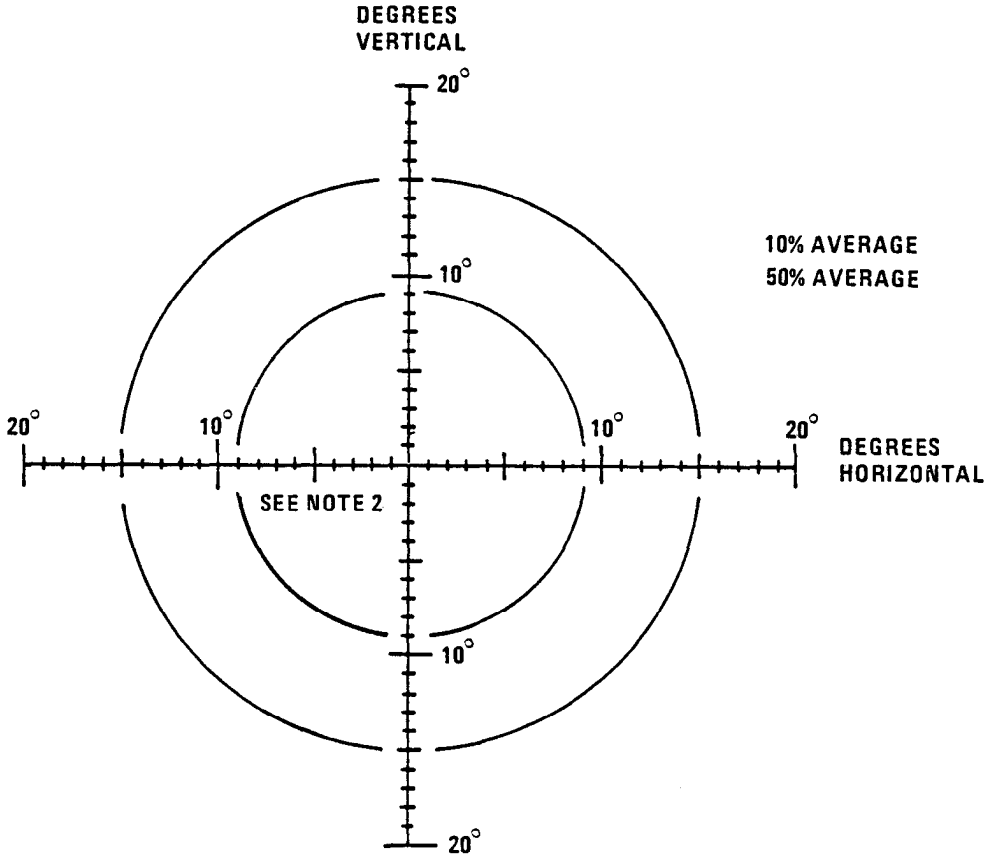
2.3.11.3 Sequenced Flasher Units. Flasher units conforming to FAA-E-2325D may be used to satisfy the requirement.

2.3.11.4 Semiflush Flasher Units. If required for installation in displaced threshold areas, flasher units shall conform to FAA-E-2628B and be installed in a base conforming to FAA-E-1315A. Caution shall be exercised to assure electrical compatibility with the remainder of the sequence flasher system.

2.3.11.5 Light Fixture Supports 0 to 6 Ft AGL. Elevated light fixtures mounted 0 to 6 ft (0 to 1.83 m) AGL are mounted on EMT or IMC fitted at the bottom with a frangible coupling conforming to FAA Drawing C-6046A.

2.3.11.6 Light Fixture Supports over 6 Ft AGL. light fixtures elevated between 6 ft and 40 ft (12.2 m) AGL are supported on approach light support towers conforming to either FAA-E-2604, Low-Impact-Resistant Structures for Medium-Intensity Approach Lighting Systems, or FAA AC 150/5345-45. Supports conforming to FAA-E-2702 may also be used but are generally more expensive. Light fixtures elevated more than 40 ft AGL are supported on 20-ft (6.1 m) telescoping masts conforming to FAA-E-2702 and FAA Drawing Series D-6155 which are installed on rigid supports.

2.3.11.7 Rigid Supports for Fixtures over 40 Ft AGL. Structural steel supports fabricated in accordance with FAA-E-910G and FAA Drawings Series D-6076, ALSF-2 Approach Lighting System 6'-0" to 40' may be used to support the 20-ft (6.1 m) telescoping light supports.



	50%	10%
a	9°	15°
b	9°	15°

NOTES:

1. ALL CONTOURS CALCULATED BY FORMULA $\frac{X^2}{a^2} + \frac{Y^2}{b^2} = 1.$
2. THE MINIMUM AVERAGE CANDELA OF THER MAIN BEAM IS 7500 Cd IN WHITE.
3. THE MAXIMUM INTENSITY SHOULD NOT EXCEED 1.5 TIMES THE ACTUAL AVERAGE.

Figure 8
Photometric Requirements for Medium Intensity Approach Lights

2.3.12 Power and Control Equipment. MALSR power and control equipment conforming to FAA-E-2325D, ALSF-2 Approach Lighting System 6′0″ to 40′, may be used to provide power and control to the lights. It will include a control cabinet which contains all devices necessary to control both the steady burning lights and the sequenced flashers and a power transformer unit capable of powering the steady burning lights at the three voltages required for the brightness steps.

2.3.13 Additional Design Guidance. Although some of the following sources are not in complete agreement with this handbook, they contain significant information that can assist in the development of MALSR plans and specifications.

2.3.13.1 Definitive Design Drawings. The following design drawings in NAVFAC P-272 apply:

1404510	MALSR Plan and System Details
1404511	MALSR System Riser Diagram
1404512	MALSR System Schematic Diagram
1404513	MALSR System Equipment Mounting Details
1404514	MALSR Tower and Foundation Details
1404515	MALSR 1,000-ft Crossbar and Foundation Details

2.3.13.2 FAA Specifications and Drawings.

FAA-C-2626A	Construction of a Medium-Intensity Approach Lighting System with Runway Alignment Indicator Lights (MALSR) and of Runway End Identification Lights (REIL) System.
FAA Drawing Series	MALSR with Threshold Lights and Low-Impact-Resistant D 6213 Series Structure.

2.3.13.3 Guide Specifications

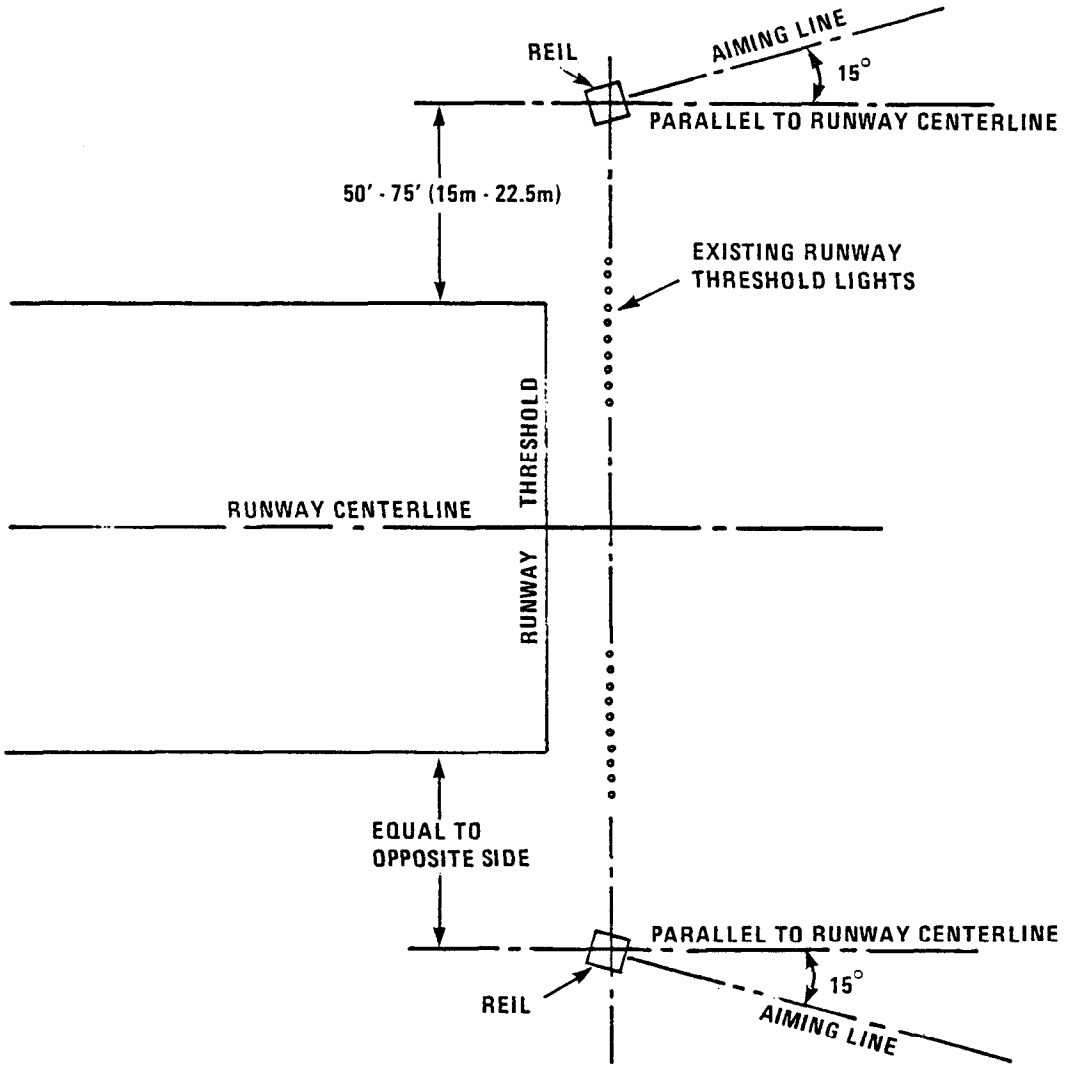
NFGS 16560	Guide Specification for Airfield Lighting

2.3.14 Compliance with International Military Standards. There are no NATO or ASCC standards for medium-intensity approach light systems.

2.4 Runway End Identifier Lights (Cat. Code 136-60)

2.4.1 Description. Runway End Identifier Lights (REIL) consist of two synchronized flashing lights located near the runway threshold to provide rapid and positive identification of the approach end of a runway. These lights have been adopted to replace the obsolete Runway Identification Lights (RIL) formerly employed as the standard.

2.4.2 Configuration. The light units are configured as shown in Figure 9. The optimum location is 50 ft (15 m) from the runway edge and in line with the existing runway threshold lights. The light units may be located laterally up to 75 ft (22.8 m) from the runway edge and longitudinally 50 ft downwind (toward the approach) from the line of the threshold. These location tolerances should be employed as required to keep the light units a



NOTES:

1. LONGITUDINAL LOCATION OF REIL FIXTURES MAY BE VARIED FROM IN LINE WITH THRESHOLD TO 50 FEET DOWNWIND OF THRESHOLD. BOTH FIXTURES WILL BE AT THE SAME DISTANCE.
2. UNIDIRECTIONAL FIXTURE IS ILLUSTRATED. FOR OMNIDIRECTIONAL FIXTURE, IGNORE HORIZONTAL AIMING.

Figure 9
Typical REIL Configuration

minimum distance of 50 ft from other runways or taxiways. The light units shall be located as nearly equidistant from the runway centerline as practicable with the difference in the distance of the two lights to the centerline not exceeding 10 ft (3 m). The elevation of both units shall be within 4.5 ft (1.38 m) of a horizontal plane through the runway centerline. When a REIL is installed on the same runway as a VASI or PAPI, the REIL light units shall be located 75 ft from the runway edge.

2.4.3 Fixtures. Light fixtures for REIL systems may be either unidirectional or omnidirectional. Both types of, fixtures should be capable of being baffled to block areas of unwanted light.

2.4.4 Orientation of Light Units

2.4.4.1 Unidirectional Systems. Unidirectional light units are aimed at an angle of 10° vertically and toed out (directed outward from a line parallel to the runway centerline) 15°. Baffles shall not be used unless warranted by user complaints of severe glare effects, flight inspection findings, and/or environmental impact. In these cases, baffles may be installed as a system option.

2.4.4.2 Omnidirectional Systems. Omnidirectional light units are aligned when light units are plumb. Baffles shall not be used unless warranted by user complaints of severe glare effects, flight inspection findings, and/or environmental impact. In these cases, baffles may be installed as a system option.

2.4.4.3 Deviations. The aiming criteria as specified may not provide satisfactory results at some locations and readjustment of either or both of the vertical and horizontal aiming angles may be required. The horizontal aiming of the beam axis shall not be less than 10° nor more than 20° outward from the line parallel to the runway centerline.

2.4.5 Power Requirements. REIL systems require 120/240 Vac type electric power. If a 120/240 Vac power source is not readily or economically available the system may be powered from the runway edge lights using a suitable power adapter as recommended by the equipment manufacturer (see Figure 10).

2.4.6 Control Requirements. REIL systems, may be controlled separately or may be coupled to the associated runway edge lights through current sensing relays or other devices. When coupled to the runway edge lights, the lights should operate as follows:

RUNWAY EDGE LIGHT SETTING	REIL SETTING
OFF	OFF
Brightness steps 1 or 2	Low intensity
Brightness step 3	Medium intensity
Brightness steps 4 or 5	High intensity

2.4.7 Equipment Requirements

2.4.7.1 Unidirectional Equipment. For undirectional equipment, fixtures, power and control equipment shall be either FAA AC 150/5345-51, Type L-849E or FAA-E-2159C.

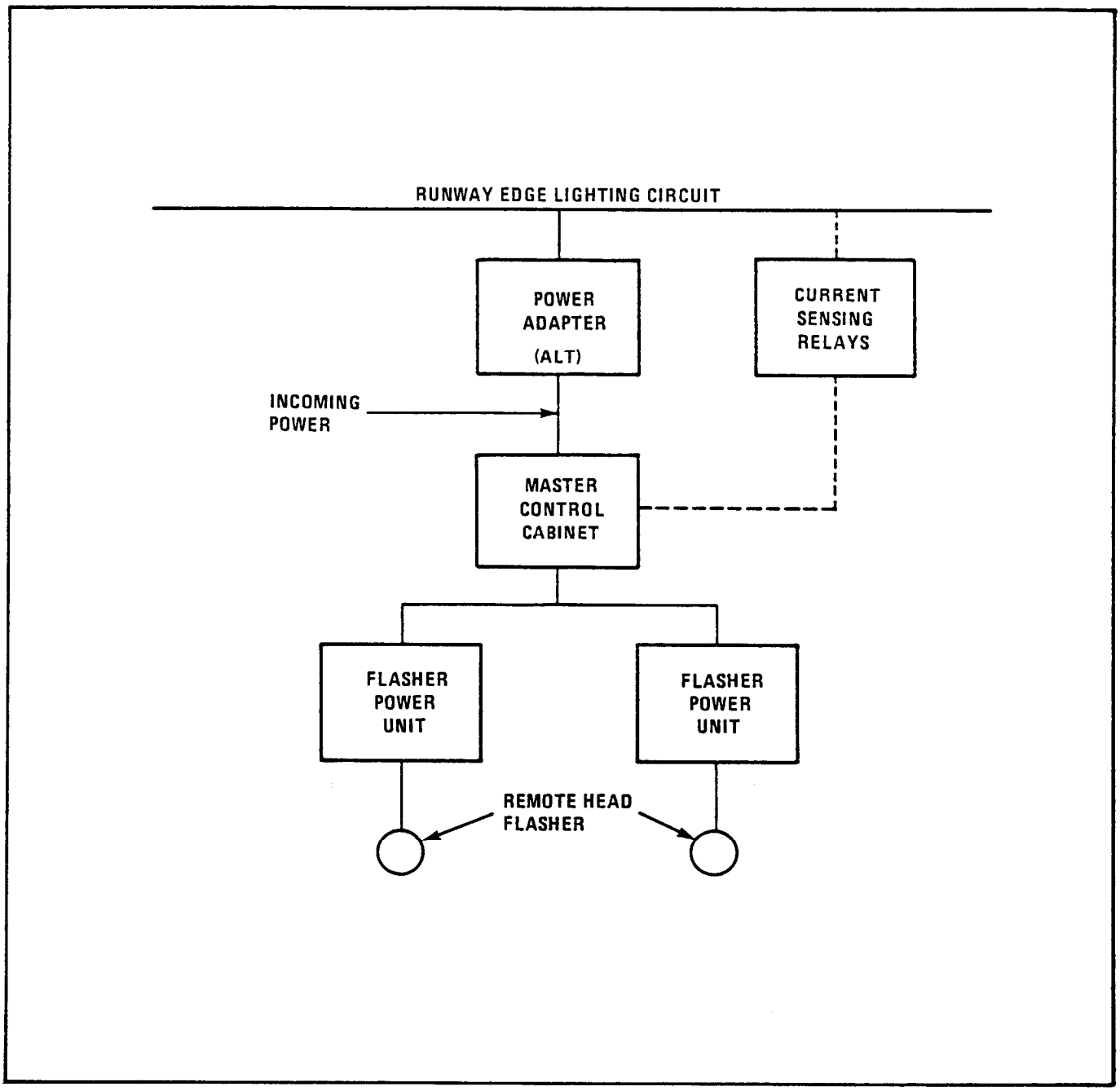


Figure 10
Block Diagram for REIL System

2.4.7.2 Omnidirectional Equipment. For omnidirectional equipment, fixtures, power and control equipment shall be either FAA AC 150/5345-51, Specification for Discharge Type Flasher Equipment, Type L-959F or FAA-E-2651.

2.4.7.3 Supports. All equipment mounted above grade will be supported on frangible couplings conforming to FAA Drawing C-6046A.

2.4.8 Additional Design Guidance. Although some of the following publications may not be in complete agreement with this handbook, they contain significant information that can assist in the development of REIL plans and specifications:

a) Definitive Design Drawings. As of the date of this publication, NAVFAC P-272 does not contain definitive design drawings for REIL installations.

b) FAA Specifications and Drawings

AA-C-2626A	Construction of a Medium-Intensity Approach Lighting System with Runway Alignment Indicator Light (MALSR) and of a Runway End Identifier Light (REIL) System FAA Drawing Series Runway End Identifier Lights sheets 8, 9, and 10 D-5888

c) Guide Specifications:

NFGS 16560	Guide Specification for Airfield Lighting

2.4.9 Compliance with International Military Standards. Facilities established in accordance with this handbook shall meet the requirements of NATO STANAG 3316, Airfield Lighting, and ASCC Air Standard 65/4, Airfield Approach Lighting, for REIL systems.

2.5 Related Lighting Systems (Cat. 134)

Visual Approach Slope Indicator (VASI) systems and Precision Approach Path Indicator (PAPI) are additional approach guidance systems not covered by this handbook. Design information for these systems may be found in NAVFAC DM-23.02, Navigational and Traffic Aids.

Section 3: RUNWAY LIGHTING SYSTEMS

3.1 High-Intensity Runway Edge Lights (Cat. Code 136-30)

3.1.1 Purpose. High-Intensity Runway Edge Lights (HIRL) are installed to provide visual guidance during takeoff and landing operations at night and under low visibility conditions.

3.1.2 Location. Runway edge lights are located on both sides of the runway on lines not more than 2 ft (0.61 m) from the edge of the full strength paving designated for runway use. Both lines of lights are to be equidistant from the runway centerline (see Figure 11). Individual lights shall be laterally not more than 2 in. (50.8 mm) from the line of lights.

Longitudinally, the lights are equally spaced along the runway light lines within ±1 ft (0.3 m). The distance between lights is determined by dividing the distance between the threshold lights into equal spaces approaching but not exceeding 200 ft (60 m). The proper number of spaces is determined by dividing the system length by 200 and, if the result is not a whole number, rounding upward to the next whole number.

Lights on opposite sides of the runway shall be placed in a line not more than 0.5° from perpendicular to the runway centerline. Fixtures shall be oriented so that the toe-in of the main beams are within 1° of being equal in both directions. Fixtures shall be mounted level to preserve the vertical aiming.

3.1.2.1 Elevated Lights. Elevated lights will be used in all instances except as noted in para. 3.1.2.3. Elevated fixtures shall be frangibly mounted a maximum of 14 in. (355.6 mm) above grade. At airfields where frequent snow accumulations of 12 in. (304.8 mm) or more are experienced the mounting height may be increased to not more than 24 in. (609.6 mm).

3.1.2.2 Semiflush Fixtures. Semiflush fixtures will be used in areas where elevated lights are subject to damage due to jet blast, operation of an arresting barrier, intersecting pavements, or interference with aircraft operation (see Figure 11). Semiflush fixtures shall not protrude more than 1 in. (25.4 mm) above the surrounding surface.

3.1.3 Power Requirements. HIRL are series circuited and generally require 6.6 A regulated electric power. While either 6.6 A or 20 A power may be used, 20 A circuits are preferred for high-intensity light systems. Care should be taken to select isolation transformers that provide the correct interface between lamp and power supply. When sizing regulators, consideration should be given to ancillary loads, such as wind indicator lights or runway distance markers which may be connected to the circuit.

3.1.4 Control Requirements. HIRL systems require on/off controls and brightness control with five intensity steps.

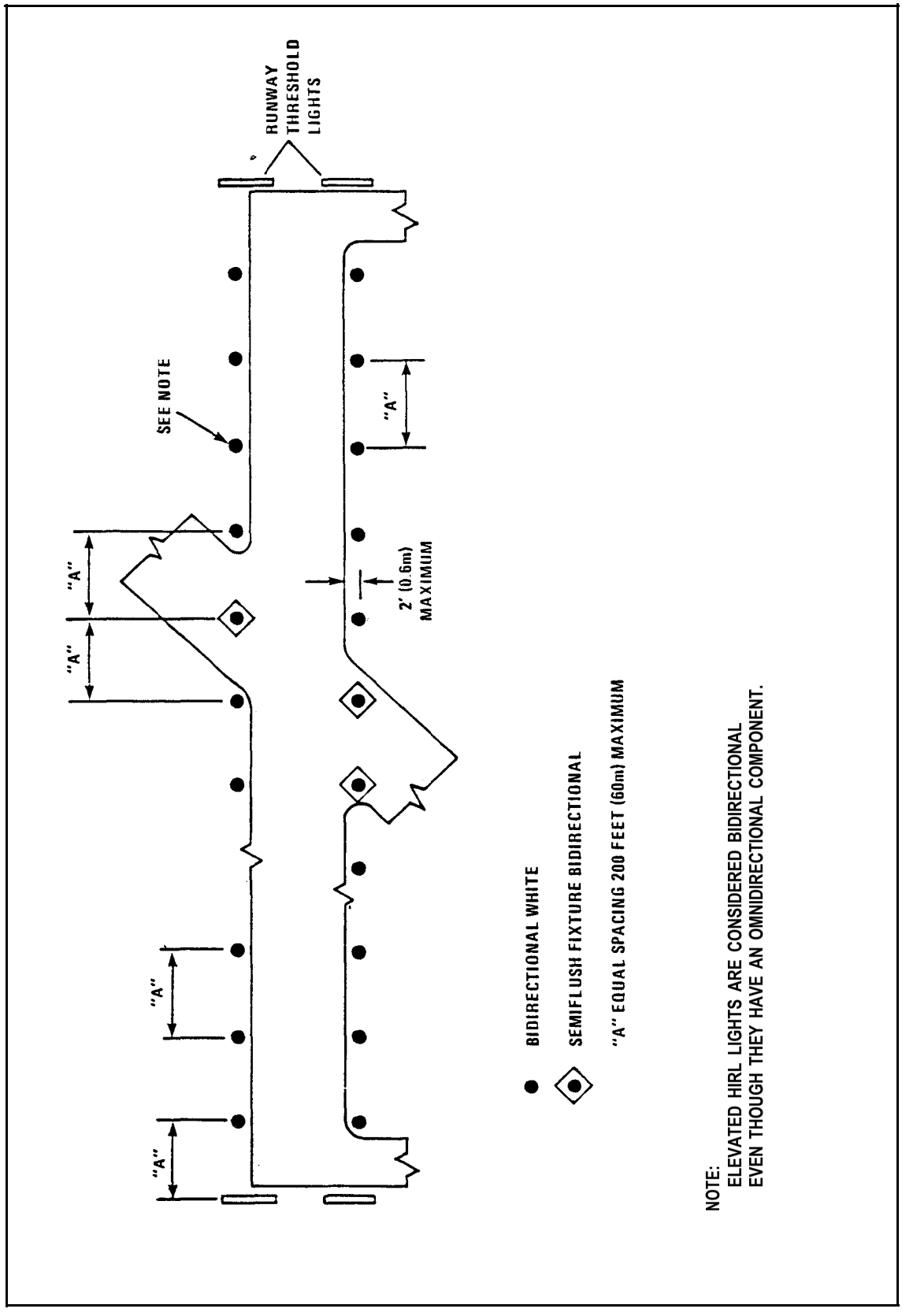


Figure 11
High Intensity Runway Edge Light Configuration

3.1.5 Equipment Requirements

3.1.5.1 Elevated Fixtures. Elevated light fixtures shall meet the requirements of MIL-L-5904D, Light, Runway Marker, Elevated, Type C-1 or FAA AC 150/5345-46 A, Type L-862. Colored filters, where required for displaced threshold areas, shall meet the requirements of the specification and be compatible with the fixture. Lamps shall be as recommended by the manufacturer to meet the photometric requirements given in Figure 12. Manufacturers may meet the requirement using different lamps. In the interest of energy conservation, the use of lower wattage lamps is preferred.

3.1.5.2 Semiflush Fixtures. Semiflush fixtures meeting the requirements of FAA AC 150/5345-46, Type L-850C will satisfy the standard. Lamps shall be as recommended by the manufacturer to meet the requirement of Figure 12. Manufacturers may meet the requirement using different lamps. In the interest of energy conservation, the use of lower wattage lamps is preferred.

3.1.6 Additional Design Guidance. Although some of the following publications may not be in complete agreement with this handbook, they contain significant information that may assist in the development of HIRL plans and specifications:

a) NAVFAC P-272 Definitive Design Drawings:

1404284	Runway Lighting, Edge Lights and Markers
1404288	Runway Lighting Ductline Plan, Handhole Details

b) FAA Advisory Circulars:

FAA AC 150/5340-24 Runway and Taxiway Edge Lighting System

c) Guide Specifications:

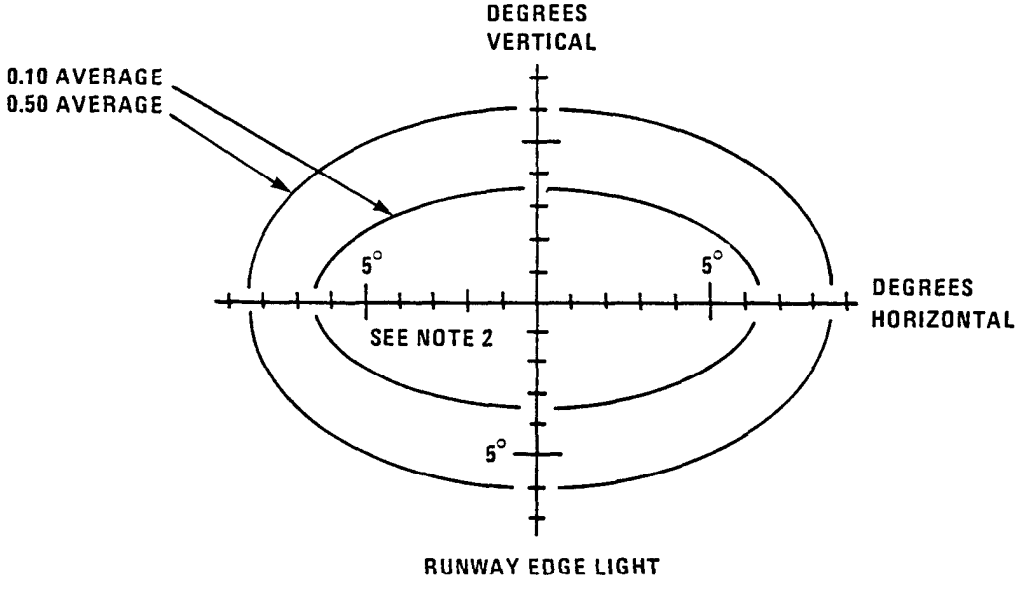
NFGS 16560	Guide Specification for Airfield Lighting

3.1.7 Compliance With International Military Standards. HIRL systems, as described, meet the requirements of NATO STANAG 3316, Airfield Lighting, and ASCC Air Standard 65/1E, Airfield Runway Lighting.

3.2 Threshold Lights (Cat. Code 136-60)

3.2.1 Purpose. Threshold lights are installed to provide positive identification of the beginning of the operational runway surface for approaching aircraft at night or under IFR conditions.

3.2.2 Basic Configuration. The threshold lights are installed in a line perpendicular to the runway centerline extended at each end of the runway. The line of lights is located outside the usable landing area a distance of not more than 5 ft (1.5 m), see Figure 13. They consist of two sets of lights. One set is centered on each line of runway edge lights. The spacings between lights in a set are 10 ft ±2 in. (3 m ± 50.8 mm).



RUNWAY EDGE LIGHT

FOR RUNWAYS 200' (60m) OR GREATER IN WIDTH

	50%	10%
a	6.5°	8.5°
b	3.5°	6.0°

NOTES:

1. ALL CONTOURS CALCULATED BY FORMULA $\frac{X^2}{a^2} + \frac{Y^2}{b^2} = 1$.
2. THE MINIMUM AVERAGE CANDELA OF THE MAIN BEAM IS 10,000Cd IN WHITE.
3. THE MAXIMUM INTENSITY SHOULD NOT EXCEED 1.5 TIMES THE ACTUAL AVERAGE.
4. FOR SEMIFLUSH FIXTURES, THE PORTION OF THE LIGHT BEAM BEING CUT OFF BY THE MOUNTING SURFACE MAY BE DISREGARDED.

Figure 12
Photometric Requirements for High Intensity Runway Edge Lights

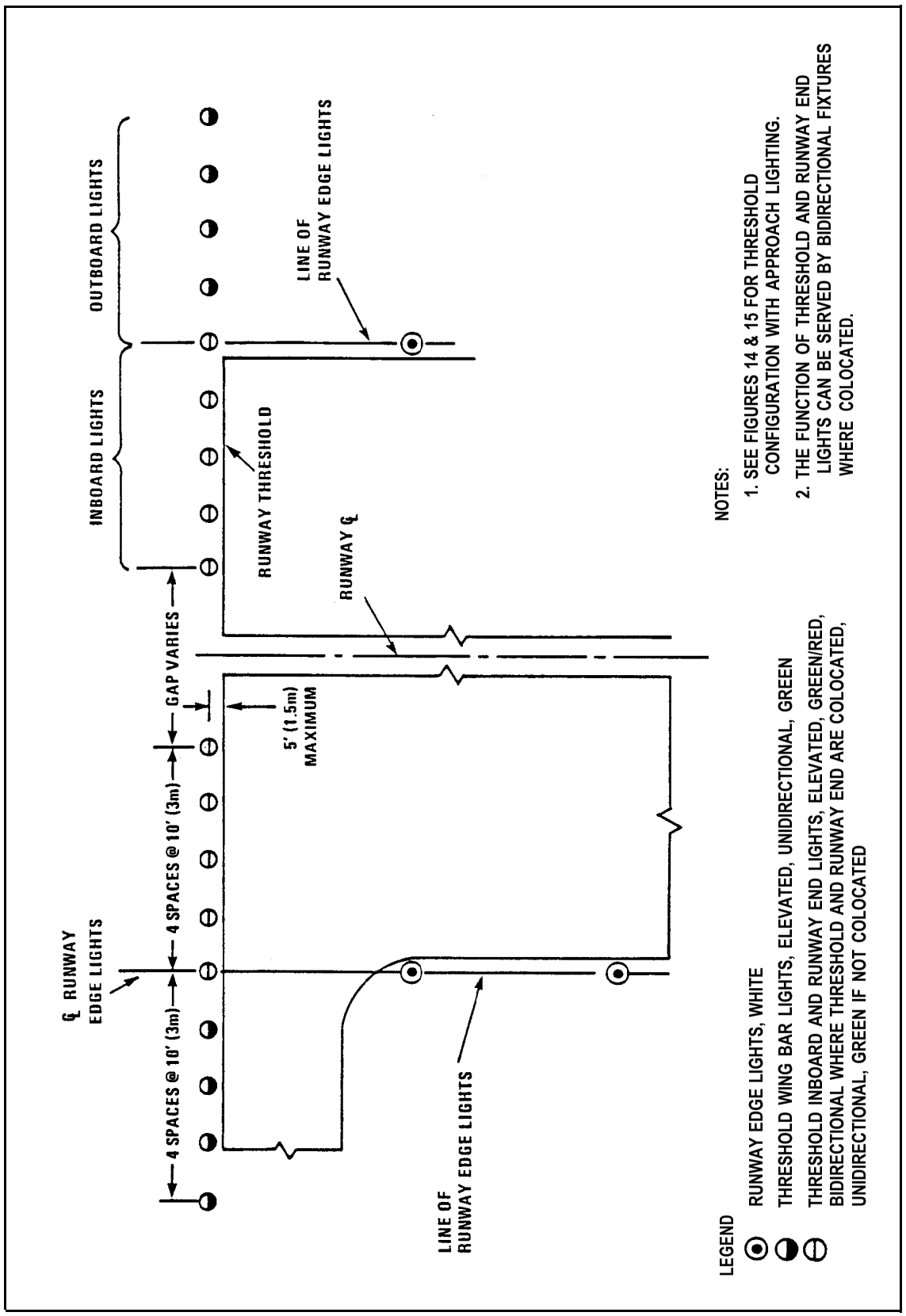


Figure 13
Basic Threshold Light Configuration

3.2.3 Enhancements with Approach Lighting. Where high intensity approach lights are installed (ALSF-1 or ALSF-2) the basic threshold lighting system will be enhanced by the installation of additional threshold lights (refer to paras. 3.2.3.1 and 3.2.3.2).

3.2.3.1 ALSF-1. Additional threshold lights shall be installed in the gap between the two sets in the basic configuration (see Figure 14). These lights shall be evenly spaced across the gap at a maximum spacing of 10 ft (3.04 m). The fixtures may be elevated except that a minimum 70 ft (21.3 m) wide "gate" centered on the runway centerline will be provided. Threshold lights in the "gate" area shall be semiflush. No part of any elevated fixture may be within 35 ft (10.6 m) of the runway centerline.

3.2.3.2 ALSF-2. Threshold Light enhancements for ALSF-2 are similar to the ALSF-1 enhancements except that the spacing for the lights in the gap is decreased so as not to exceed 5 ft (1.5 m) and additional lights are installed in the basic configuration to reduce the spacing to 5 ft in that area as well. See Figure 14 for details on the gap area and Figure 15 for details on the enhancements to the area of the basic configuration.

3.2.4 Fixtures. Except where installed in displaced thresholds, or where subject to arresting gear damage, elevated fixtures shall be used in the basic configuration. For displaced thresholds, or where subject to arresting gear damage, the fixtures shall be semiflush. Elevated fixtures are to be frangibly mounted not more than 14 in. (355.6 mm) above the runway surface and all fixtures should be a uniform distance above grade. At airfields where frequent snow accumulations of 12 in. (304.8 mm) or more are experienced the mounting height may be increased to not more than 24 in. (609.6 m). Semiflush fixtures shall project not more than 1 in. (25.4 mm) above the surrounding surface. While unidirectional fixtures emitting green light toward the approach are satisfactory, bidirectional fittings emitting green light toward the approach and red light toward the runway may be substituted as required where the threshold lights and runway end lights are collocated. Semiflush fixtures and bidirectional elevated fixtures have fixed vertical and horizontal aiming.

Where bidirectional fixtures having main beams that are not aimed 180° apart in the horizontal are used, the main beams shall be symmetrically toed-in toward the runway centerline. Unidirectional fixtures are to be installed with the main beam parallel to the runway centerline in the horizontal plane. Unidirectional elevated fixtures should be aimed vertically at an angle of 6°.

3.2.5 Power and Control Requirements. The threshold lights in the basic configuration are connected to and controlled by the runway edge light power and control system. The threshold light enhancements are connected to and controlled by the associated approach lighting system.

3.2.6 Equipment Requirements

3.2.6.1 Elevated Bidirectional Lights. Elevated bidirectional light fixtures shall be in accordance with MIL-L-26990B, Light, Marker, Airport Approach, High Intensity Type MB-1 with 503 W, 20A, Q20A/T20/3 lamps (red/green filters may be used to satisfy the requirement of this handbook). Dichroic green filters may be used to maximize light output.

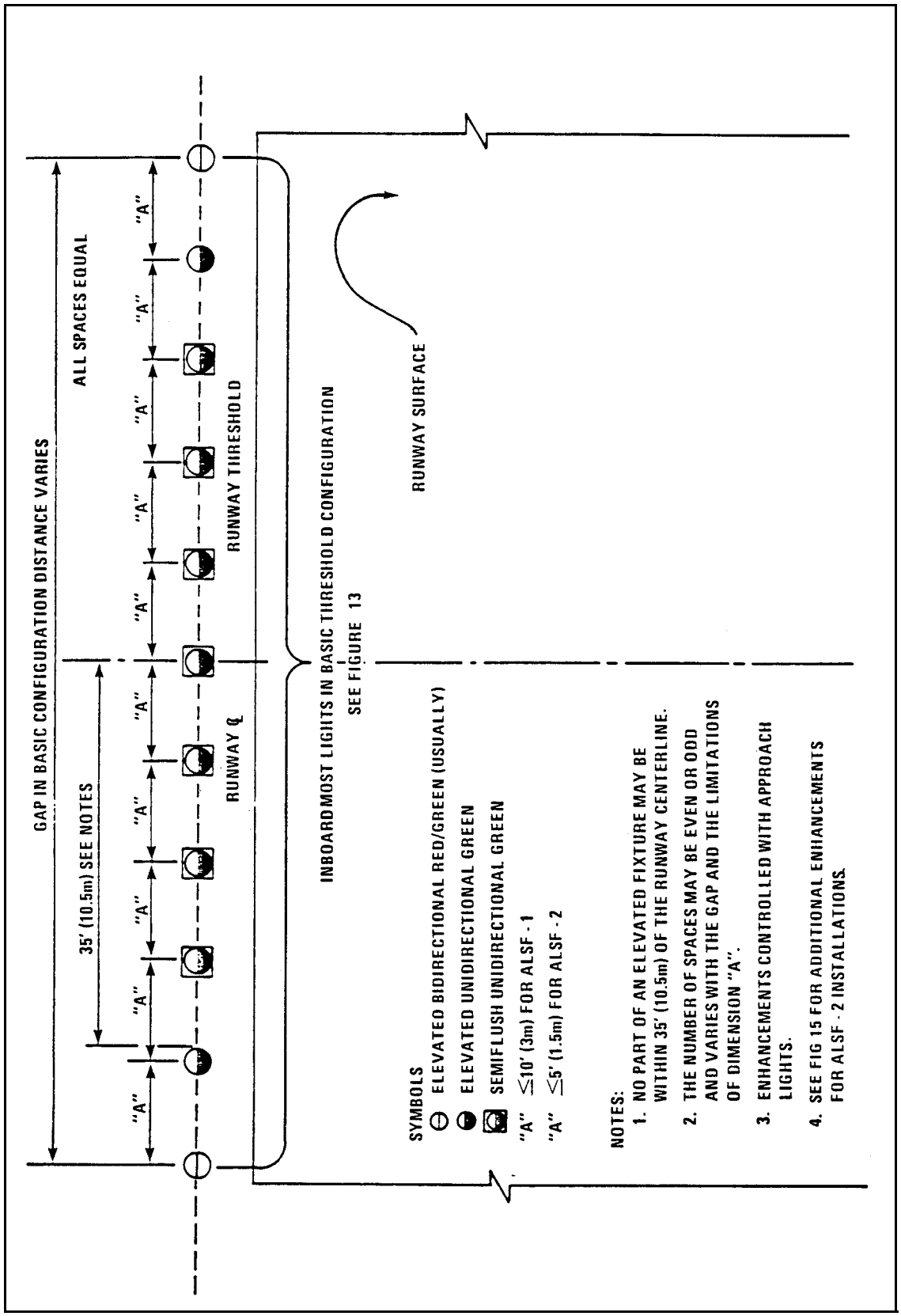


Figure 14
Typical Threshold Light Enhancement for Approach Lights

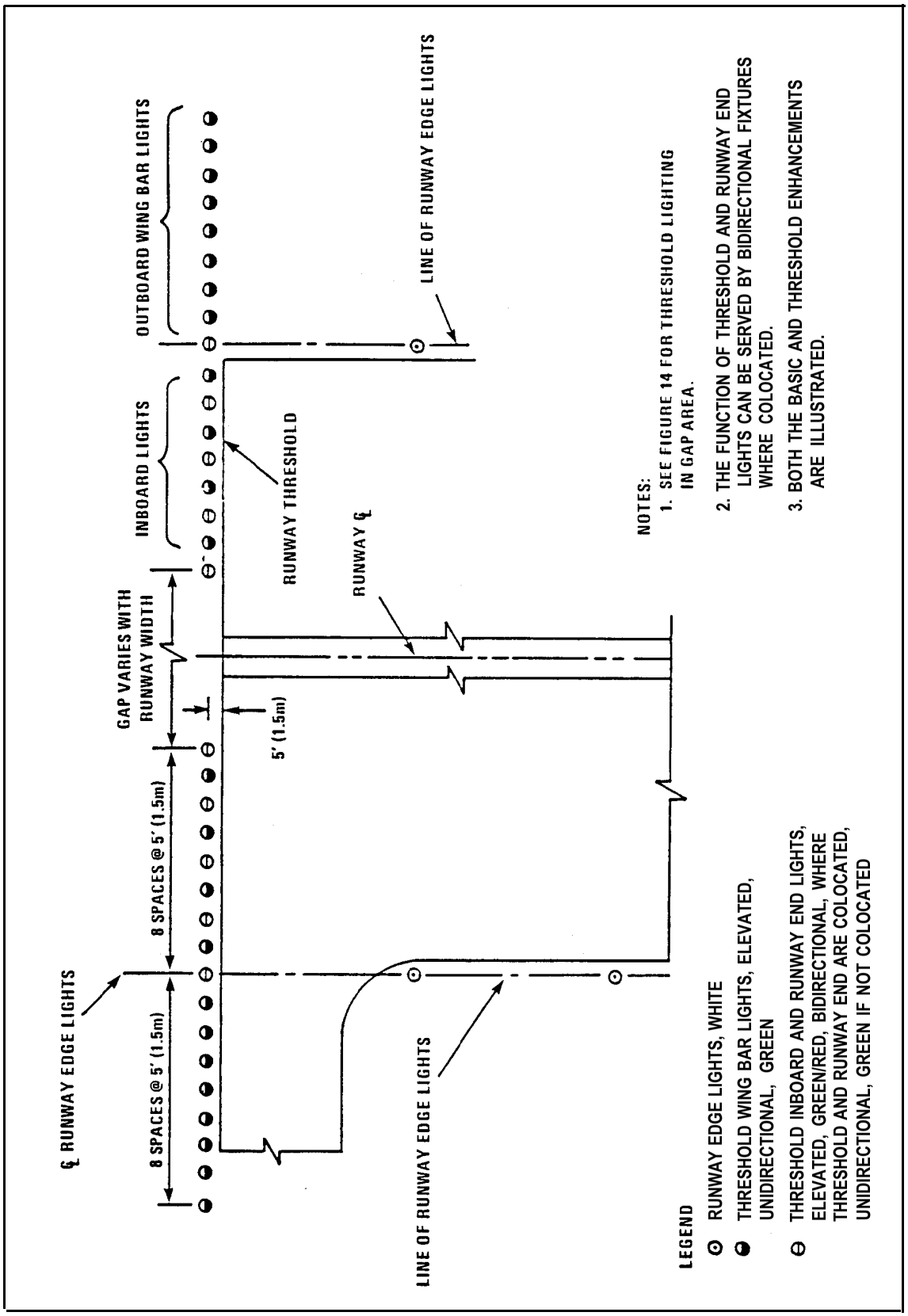


Figure 15
ALSF-2 Threshold Light Enhancements in the Basic Configuration Area

3.2.6.2 Elevated Unidirectional Lights. Elevated unidirectional light fixtures shall be in accordance with MIL-L-26764B, Light, Marker, Airport Approach, High Intensity Type MB-2 or FAA-E-982G with green filters. Fixtures conforming to FAA-E-982G are preferred for operational safety, because they are lighter in weight and more easily fractured into smaller pieces upon impact. PAR-56 lamps meeting the photometric requirements of Figure 16 shall be used.

3.2.6.3 Semiflush Lights. Semiflush fixtures shall be in accordance with FAA AC 150/5345-46, Type L-850E with green filters. Dichroic green filters shall be used in the fixtures. Lamps shall be as recommended by the manufacturer to meet the photometric requirements of Figure 16.

3.2.7 Additional Design Guidance. Although the following publications may not be in complete agreement with this handbook, they contain significant information to assist in the design of threshold lighting systems. Where conflict exists between this handbook and the sources cited below, this handbook takes precedence:

a) NAVFAC P-272 Definitive Design Drawings:

1404286	Runway Lighting, Touchdown Zone and Threshold Lights
1404279	Approach lighting System, Threshold, 500-foot and Wing Bars

b) FAA Advisory Circulars:

AC 150/5340-24 Runway and Taxiway Edge Lighting System

c) Guide Specifications:

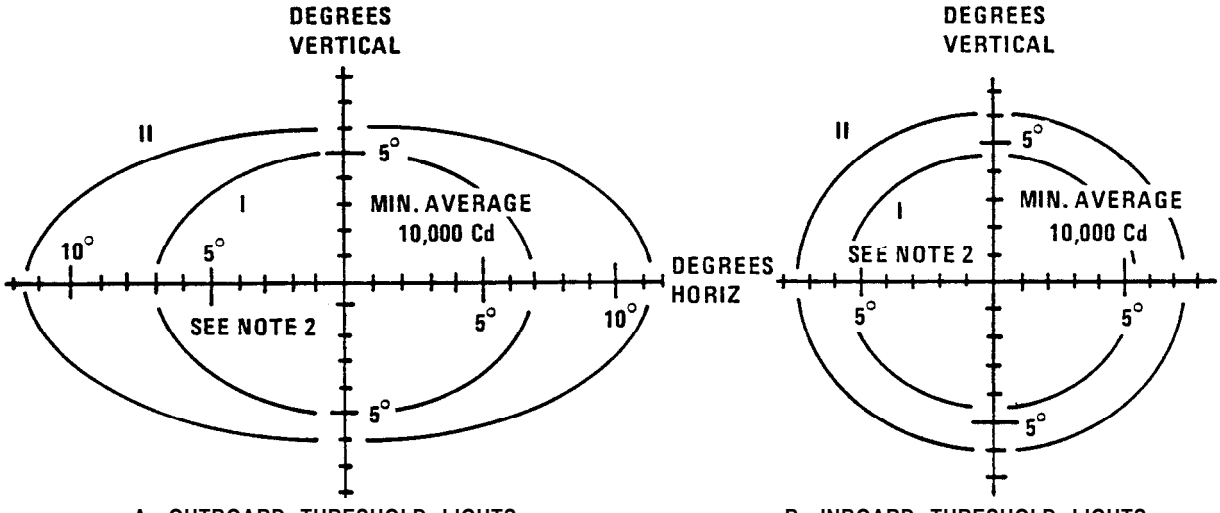
NFGS 16560 Guide Specification for Airfield Lighting

3.2.8 Compliance with International Military Standards. Threshold lighting systems installed in accordance with this handbook shall meet the requirements of NATO STANAG 3316, Airfield Lighting, and ASCC Air Standard 65/1E, Airfield Runway Lighting, provided that the number of bidirectional fixtures installed is limited to the minimum number required to satisfy the standard for runway end lights.

3.3 Runway End Lights (Cat. Code 136-60)

3.3.1 Purpose. Runway end lights are installed to define the end of the operational runway surface for aircraft on landing rollout or takeoff. They are required on all lighted runways.

3.3.2 Configuration. A minimum of 10 runway end lights are to be arranged in two groups symmetrical about and perpendicular to the runway centerline pointing towards the runway side of the threshold at each end of the runway. Intervals between lights in each group are not to exceed 10 ft (3.05 m). They are to be positioned not more than 5 ft (1.5 m) beyond the length of usable pavement and the outboard most light in each group will be in the line of the runway edge lights (see Figure 17).



A. OUTBOARD THRESHOLD LIGHTS, GREEN, ELEVATED

	I = 50%	II = 10%
a	7.0°	11.5°
b	5.0°	6.0°

B. INBOARD THRESHOLD LIGHTS, GREEN, ELEVATED OR SEMIFLUSH

	I = 50%	II = 10%
a	5.5°	7.5°
b	4.5°	6.0°

NOTES:

1. ALL CONTOURS ARE ELLIPSES CALCULATED BY FORMULA $\frac{X^2}{a^2} + \frac{Y^2}{b^2} = 1.$
2. THE MINIMUM AVERAGE INTENSITY OF THE MAIN BEAM (INSIDE CONTOUR I) IS 10,000 Cd, AVIATION GREEN. MAXIMUM INTENSITY SHOULD NOT EXCEED 1.5 TIMES ACTUAL AVERAGE.
3. MINIMUM INTENSITY OF I = 50% AND II = 10% OF REQUIRED MAIN BEAM INTENSITY.
4. PORTIONS OF THE LIGHT BEAM CUT OFF BY THE MOUNTING SURFACE MAY BE DISREGARDED.

Figure 16
Photometric Requirements for Threshold Lights

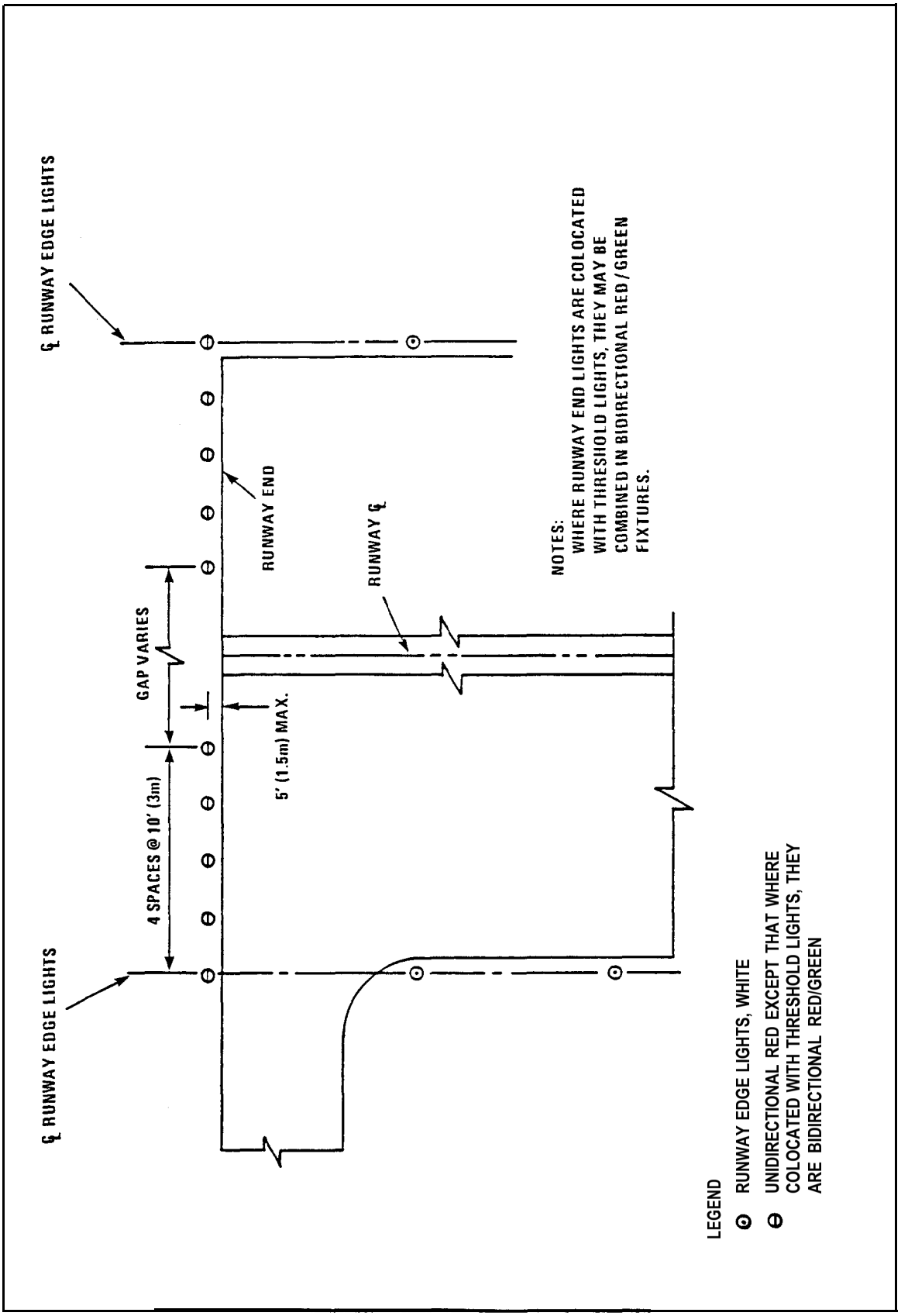


Figure 17
Typical Runway End Light Configuration

3.3.3 Fixtures. Runway end light fixtures are elevated to the same height above the surface as the runway edge and threshold lights. If collocated with threshold lights, they may be incorporated in bidirectional fixtures with red/green filters. If installed at the end of the usable pavement in displaced threshold areas, they are bidirectional red.

3.3.4 Power and Control Requirements. Runway end lights are connected to and controlled by the associated runway edge lighting circuit.

3.3.5 Equipment

3.3.5.1 Collocated Thresholds. Bidirectional fixtures shall be in accordance with MIL-L-26990B, Type MB-1 with 503 W 20 A, Q20A/T20/3 lamps with red/green filters.

3.3.5.2 Displaced Threshold. Where installed at the end of the usable pavement in displaced threshold areas fixtures and lamps as described in para. 3.3.5.1 may be used with red/red filters or fixtures conforming to FAA AC 150/5345-46, Type L-862 may be used with red/red filters and lamps as recommended by the manufacturer.

3.3.6 Additional Design Guidance. Although the following publications may not be in complete agreement with this handbook, they do contain significant information to assist in the design of runway end lighting systems. Where conflict exists between this handbook and the sources listed below, this handbook takes precedence:

a) NAVFAC P-272 Definitive Design Drawings:

1404286	Runway Lighting, Touchdown Zone and Threshold Lights
1404279	Approach Lighting System, Threshold, 500-ft and Wing Bars

b) FAA Advisory Circulars:

AC 150/5340-24	Runway and Taxiway Edge Lighting Systems

c) Guide Specifications:

NFGS 16560	Guide Specification for Airfield Lighting

3.3.7 Compliance with International Military Standards. Runway end lighting systems as described meet the requirements of NATO STANAG 3316, Airfield Lighting, and ASCC Air Standard 65/1E, Airfield Runway Lighting.

3.4 Lighting With Displaced Thresholds (Cat. Code 136-60)

3.4.1 General. The threshold, which is the beginning of the landing area, may not be at the beginning of the full strength runway pavement. It may have been displaced because of obstructions in the approach or other operational problems. Where area of full strength pavement in front of the threshold is required for takeoff operations or for rollout on landings

from the opposite direction, changes to the standards for runway lighting will be necessary.

3.4.2 Permanently Displaced Thresholds. See Figure 18 for a typical layout of permanently displaced threshold areas.

Ideally, the threshold lights will be installed on the theoretical threshold line but may be displaced a maximum of 2 ft (0.6 m) into the approach to avoid construction joints. They are configured as described in para. 3.2. Threshold fixtures in the paved area shall be semiflush.

Where the permanently displaced threshold area is not to be used for rollout or takeoff, it is considered to be part of the paved overrun and will be lighted and marked as such.

3.4.2.1 Runway End Lights. Runway end lights shall be installed in accordance with para. 3.3, with dimensions referenced from the end of the usable takeoff/rollout area.

3.4.2.2 Runway Edge Lights. Runway edge lights in the displaced section shall be modified to show red toward the approach direction and white toward the runway.

3.4.2.3 Runway Centerline Lights. Runway centerline lights facing the approach shall be blanked in the displacement area if the length of the displacement is less than 700 ft (213.4 m). If the displacement is 700 ft or greater, the centerline lights in the area shall be circuited separately and switched so as to be capable of being turned off during landing operations. If a high-intensity approach lighting system is installed in the displacement area, this switching capability is not required.

3.4.2.4 Approach Lights. Approach lights will be installed in accordance with this handbook, using the theoretical threshold line as the reference and the threshold lights shall be enhanced as appropriate for the system being installed.

3.4.3 Temporarily Displaced Thresholds. Where the threshold is only temporarily displaced and the duration of the displacement is insufficient to warrant the relocation of all facilities, the following shall apply:

a) The permanent threshold lights will be disabled and a set of temporary threshold lights conforming to para. 3.2.2, shall be installed on the line of the displaced threshold. The outboard lights may be stake mounted and the inboard lights may be mounted on planking or otherwise, but must be securely held in place so as to avoid accidental movement. Cabling and transformers may be placed above ground but must be protected from accidental damage.

b) Runway edge lights in the displacement area will be provided with red filters in both directions.

c) Any approach lighting system, VASI, or PAPI system serving that end of the runway will be disabled.

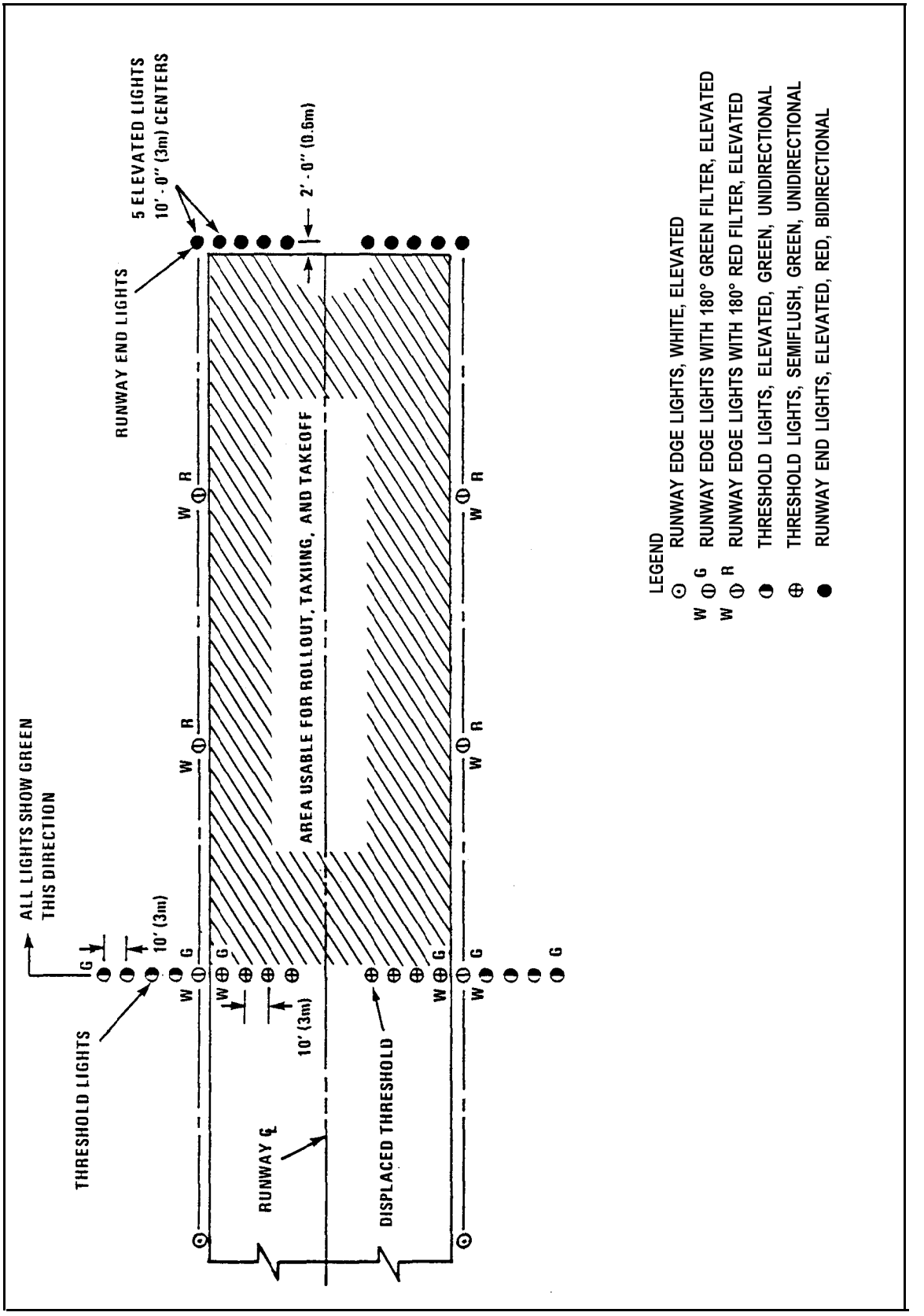


Figure 18
Permanent Displaced Threshold Configuration

d) The number panels of runway distance markers facing toward the opposite end approach shall be blanked or temporarily replaced with new number panels reflecting the shorter distance to go. Renumbering will be done so that at least 1,000 ft (304.8 m) remains between the last number (#1) and the displaced runway end.

e) Runway centerline lights will have red filters replaced or relocated to conform to the standard for the last 3,000 ft (914.4 m) of runway.

3.5 Runway Centerline Lights (Cat. Code 136-35)

3.5.1 Description. Runway Centerline Lights (RCL) consist of a row of bidirectional lights installed along the runway centerline to provide lateral guidance during rollout and takeoff roll. They are color coded at each end to provide "distance to go" information.

3.5.2 Configuration. The lights shall be in a straight line which shall be offset not more than 2 ft (0.6 m) to avoid conflict with centerline markings and construction joints. The lights shall be either "tailhook resistant" spaced at 25 ft (7.6 m) or "standard duty" spaced at 50 ft (15.2 m), as directed. The lights shall be white except that the roll out ends shall be color coded facing the approach ends in the following manner. The lights facing the approach shall be alternate red and white from a point 3,000 ft from the runway end to 1,000 ft from the runway end and shall be all red thereafter (see Figure 19).

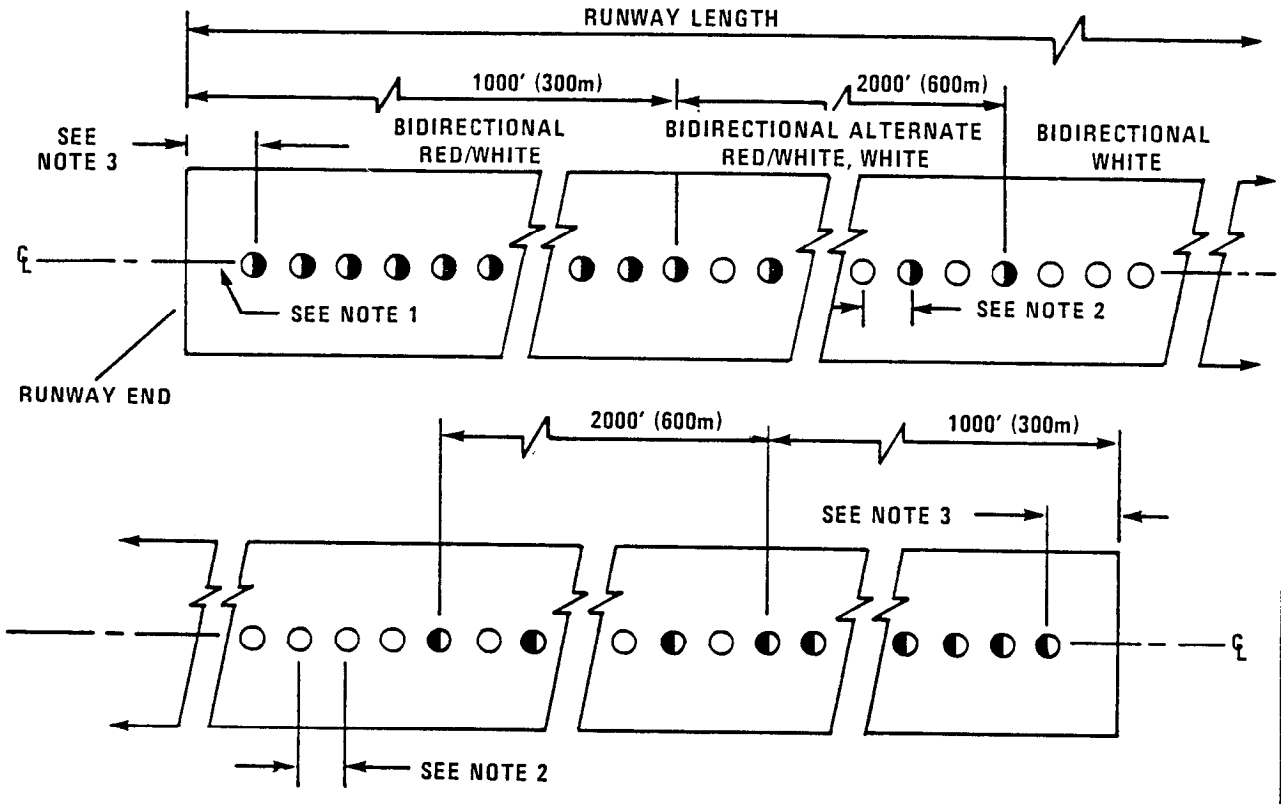
3.5.3 Fixtures. The fixtures shall be bidirectional semiflush, either tailhook resistant or standard duty as ordered. Fixtures may not extend more than 0.5 in (12.7 mm) above the pavement.

3.5.4 Power and Control System. RCL systems require independent on/off control and brightness control with five intensity steps. The controls shall be arranged so that the RCL system cannot be energized unless the associated runway edge lights are on.

3.5.5 Equipment Requirements

3.5.5.1 Hook-Resistant Light Fixtures. There is no qualifying specification for these hook-resistant light fixtures. The fixture generally used is referred to as an L-852N-2 since it is a derivative of the FAA AC 150/5345-46, Type L-852 fixture. The L-852N-2 is a ruggedized version which is designed specifically for USN application. Crouse Hinds Corporation is the only known manufacturer. The fixture is available in Types V, VI, VII, and VIII. Types V and VI are designed to be inset directly in pavement and Types VII, and VIII are designed for installation on mounting bases. Lamps are to be 65 W of a type recommended by the fixture manufacturer. Where more than one fixture is connected to a single isolation transformer, the fixtures shall be ordered with bypass devices or relays.

3.5.5.2 Standard Duty Light Fixtures. Fixtures shall be FAA AC 150/5345-46, Type L-850 A. Class 1 fixtures are designed for insetting directly in pavement and class 2 fixtures are designed for installation *on* mounting bases. Lamps shall be as recommended by the manufacturer to meet the photometric requirements of the Advisory Circular. Where more than one



NOTES:

1. THE RCL SHALL BE OFFSET NOT MORE THAN 2 FEET (0.6m) RIGHT OR LEFT OF THE RUNWAY CENTERLINE. THE LATERAL TOLERANCE FROM THE LINE OF LIGHTS ± ONE INCH (25mm).
2. THE RCL SHALL BE EQUALLY SPACED AT 25 FEET (7.5m) FOR HOOK RESISTANT LIGHTS AN0 50 FEET (15m) FOR STANDARD DUTY LIGHTS. THE LONGITUDINAL TOLERANCE IS ±2 FEET (0.6m).
3. THE FIRST LIGHT FROM EITHER END OF THE RUNWAY SHALL BE NOT LESS THAN 12.5 FEET (4.2m) AND NOT MORE THAN 25 FEET (7.5m) FOR HOOK RESISTANT FIXTURES AN0 FOR STANDARD DUTY FIXTURES NOT LESS THAN 50 FEET (15m) AND NOT MORE THAN 87.5 FEET (26.4m).

SYMBOLS

○ BIDIRECTIONAL RCL - WHITE BOTH DIRECTIONS

◐ BIDIRECTIONAL RCL - RED IN DIRECTION OF BLACK SIDE, WHITE IN DIRECTION OF WHITE SIDE

Figure 19
Runway Centerline Lighting Layout

fixture is connected to a single isolation transformer, the fixtures shall be ordered with bypass devices or relays.

3.5.6 Additional Design Guidance. Although the following publications may not be in complete agreement with this handbook, they contain significant information to assist in the design of-runway centerline lighting systems. Where conflict exists between this handbook and the sources listed below, this handbook shall take precedence:

a) NAVFAC P-272 Definitive Design Drawings:

1404283	Runway Lighting Circling Guidance, Touchdown Zone and Centerline Plans and Typical Wiring

b) FAA Advisory Circulars:

FAA AC 150/5340-4	Runway Centerline and Touchdown Zone Lighting Systems

c) Guide Specifications:

NFGS 16560	Guide Specification for Airfield Lighting

3.5.7 Compliance with International Military Standards. Standard duty RCL fixtures installed in accordance with this handbook satisfy NATO STANAG 3316, Airfield Lighting, and ASCC Air Standard 65/12, Category II Airfield Lighting and Marking Standards. Systems employing hook-resistant fixtures will not meet the photometric requirement of NATO or ASCC.

3.6 Touchdown Zone Lights (Cat. Code 136-55)

3.6.1 Description. Touchdown Zone (TDZ) lights are a system of lights installed in the runway pavement to define the flareout and touchdown area to approaching aircraft.

3.6.2 Location. TDZ lights consist of two rows of high-intensity light barrettes arranged symmetrically about the centerline of the runway. The two rows of light barrettes are located within the TDZ of the runway. The system extends from the threshold of the usable landing area toward to upwind end of the runway, a distance of 3,000 ft (914.4 m). The light barrettes shall be located in each row at 100-ft (30.5 m) intervals. Each light barrette shall contain three lights spaced at 5 ft (1.5 m) on center. The inboard light shall be 36 ft (10.97 m) from the runway centerline (see Figure 20).

3.6.3 Fixture Requirements. TDZ lights shall be unidirectional white and shall be semiflush, with no part of the fixture protruding more than 0.5 in (12.7 mm) above the surrounding surface.

3.6.4 Power and Control Requirements. TDZ lighting systems require independent on/off controls and brightness controls with five intensity steps. They shall be interconnected with the associated RCL system so that they may not be energized unless the RCL system is on.

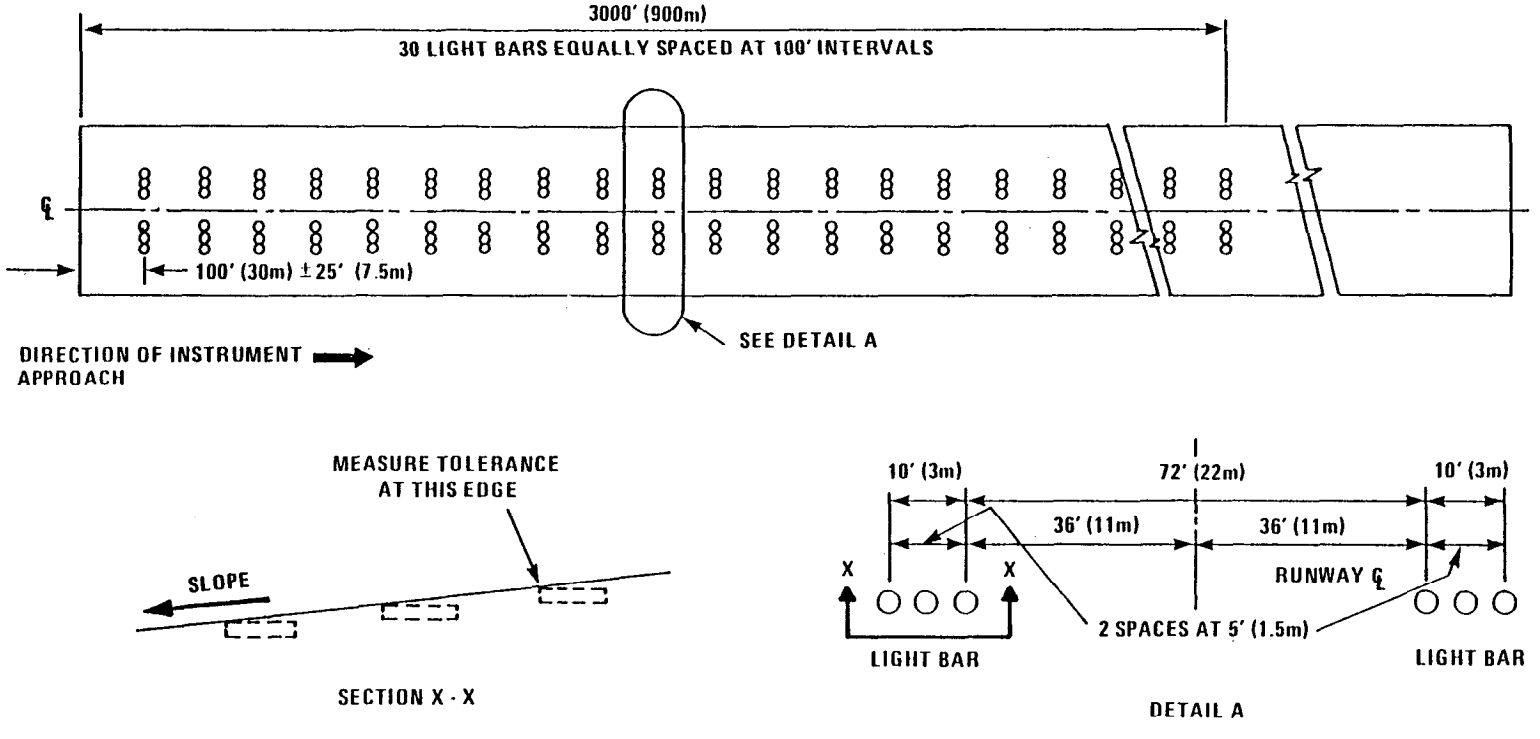


Figure 20
Touchdown Zone Lighting Layout

NOTES:

1. THE LONGITUDINAL INSTALLATION TOLERANCE IN LOCATING THE PAIRS OF TRANVERSE LIGHT BARS SHOULD NOT EXCEED 2 FEET (0.6) LATERAL TOLERANCE OF LIGHTS IN A BAR IS 1 (25mm).
2. THE SPACING BETWEEN THE INNERMOST TOUCHDOWN ZONE LIGHT FIXTURES SHOULD BE UNIFORM THROUGHOUT THE LENGTH OF THE SYSTEM. THIS SPACING IS 72 FEET (22m). WHERE CONSTRUCTION PROBLEMS PREVENT THIS SEPARATION THE UNIFORM SPACING IS REDUCED TO NOT LESS THAN 65 FEET (20m).

3.6.5 Equipment Requirements

3.6.5.1 Fixtures. TDZ fixtures shall conform to FM AC 150/5345-46 A, L-850B. Lamps shall be as recommended by the manufacturer to meet the photometric requirements of the Advisory Circular. Manufacturers may meet the requirement using different lamps. In the interest of energy conservation, the use of lower wattage lamps is preferred. Where more than one fixture is connected to an isolation transformer, the fixtures shall be ordered with bypass devices or relays.

3.6.6 Additional Design Guidance. Although the following publications may not be in complete agreement with this handbook they contain significant information to assist in the design of TDZ lighting systems. Where conflict exists between this handbook and the sources listed below, this handbook shall take precedence:

a) NAVFAC P-272 Definitive Design Drawings:

1404283	Runway Lighting Circling Guidance, Touchdown Zone and Centerline Plans and Typical Wiring

b) FAA Advisory Circulars:

FAA AC 150/5340-4	Runway Centerline and Touchdown Zone Lighting Systems

c) Guide Specifications:

NFGS 16560	Guide Specification for Airfield Lighting

3.6.7 Compliance with International Military Standards. These standards satisfy the requirements of ASCC Air Standard 65/12, Category II Airfield Lighting and Marking Standards, and for NATO STANAG 3316, Airfield Lighting.

3.7 Circling Guidance Lights (Cat. Code 136-30)

3.7.1 Description. A Circling Guidance Light (CGL) system consists of a line of white lights on each side of the runway. They shall be installed only where runway edge lights are inadequate for circling approach procedures.

3.7.2 Configuration. CGL lights are arranged in straight lines parallel to the runway centerline. The lines of lights shall be not less than 50 ft (15 m) and not more than 75 ft (22.8 m) from the runway edge. Circling guidance lights shall be a minimum of 10 ft (3 m) further from the runway than the runway distance marking if present. The lights shall be spaced 1,000 ft (305 m) ±100 ft (30.5 m) apart with the first (end) lights located down the runway from the runway end as follows: If the runway length is not an exact multiple of 1,000 ft, the extra distance is evenly divided into two parts and added to the distance of the end lights from the runway ends. As an example; if the runway length is 6,500 ft (1,981.2 m), the extra 500 ft (152.4 m) adds 250 ft (76 m) for a total of 1,250 ft (381 m) as the distance the end lights are from the runway ends. This method of adjusting for odd runway lengths permits spacing of all lights at 1,000 ft intervals and places the CGL fixtures with the runway distance markers. The CGL fixtures are elevated and

frangibly mounted at a height of not more than 36 in. (914.4 mm) above the elevation of the edge of the runway. The CGL fixtures shall be oriented horizontally with the direction arrow (10° azimuth) pointing toward and perpendicular to the runway centerline with a tolerance of ± 3°.

The vertical alignment is fixed and only requires the reference plane of the fixture to be level. If CGLs are installed on parallel runways, the lights between the runways may be omitted.

3.7.3 Control Requirements. Circling guidance lights require on/off control and a 3-step intensity control. Five intensity steps may be provided where available.

3.7.4 Electrical Requirements. Circling guidance lights are connected to series current regulated lighting circuits. These lights normally use lamps rated for 20 A. If connected to 6.6 A circuits, care should be taken to use the proper isolation transformer.

3.7.5 Equipment Requirements. Fixtures shall be in accordance with MIL-L-22252B with 503 W, 20 A, 20 A/T20/3 lamps.

3.7.6 Additional Design Guidance

3.7.6.1 NAVFAC P-272 Definitive Design Drawings. The following NAVFAC P-272, Definitive Design Drawings, may be helpful in the design of CGL:

1404283	Runway Lighting, Circling Guidance
1404285	Runway Lighting, Circling Guidance and Edge Lights

3.7.6.2 Guide Specifications:

NFGS 16560	Guide Specification for Airfield Lighting

3.7.7 Compliance with International Military Standards. CGL systems shall meet the following international military standards:

a) ASCC - There are no ASCC standards for CGLs.

b) NATO - This standard does not comply with the standards for CGLs contained in NATO STANAG 3316, Airfield Lighting.

3.8 Other Runway Lighting Systems. The requirement for lighted runway distance markers and lighted arresting gear markers which may be considered runway lighting systems are found in DM-23.02, Navigational and Traffic Aids.

Section 4: TAXIWAY LIGHTING

4.1 Taxiway Edge Lighting (Cat. Code 136-50)

4.1.1 System Description. Taxiway edge lights are a system of blue lights arranged to define the lateral limits and direction of taxiing routes. They are the USN standard for all lighted taxiways.

4.1.2 Configuration. The taxiway edge light configuration consists of a line of lights paralleling each side of the taxiway. Each line of taxiway edge lights shall be, preferably 2 ft (0.6 m), but no more than 5 ft (1.5 m) from the edge of the taxiway and at least 2 ft outside the line of any runway edge lights. The line of lights on both sides of a taxiway shall be the same distance from their respective taxiway edges. When a runway or a portion of a runway is part of a regularly used taxiing route, taxiway edge lights shall be provided in addition to the runway lights.

4.1.3 Edge Light Spacing. For determining the spacing of lights along a taxiway, the taxiway is sectioned on the basis of discontinuities encountered along its length, such as intersections with runways and other taxiway, or changes in alignment or width. A discontinuity on one side of a taxiway is applied to the other side as well. The design of a taxiway lighting system should proceed as outlined below (Figures 21 and 22 illustrate most situations which will be encountered):

a) Place an edge light at each discontinuity. In the case of intersecting pavements they would be placed at the point of tangency (PT) of each fillet. A companion light is to be placed on the side opposite the discontinuity as well.

b) Place edge lights along all straight taxiway edges at uniform intervals between the lights which were placed in para. 4.1.3.a. Where the length of the section is greater than 300 ft (91.4 m), the spacing shall not exceed 200 ft (61 m). If the section under consideration is opposite an intersecting taxiway or apron area, the uniform spacing shall not exceed 50 ft (15.2 m). Where the length of the section is less than 300 ft, the spacing shall not exceed 50 ft. Where the light spacing exceeds 100 ft (30 m), place one additional light 40 ft (12 m) from each end of the section. Place companion lights along the opposite edge where there is not intersecting pavement. All companion lights shall be on lines perpendicular to the taxiway centerline.

c) Place edge lights along all curved taxiway sections uniformly spaced in accordance with Figure 23.

d) Place uniformly spaced edge lights at all fillets in accordance with the criteria in Figure 23. The spacing shall not exceed one-half the width of the straight taxiway section. on all curves in excess of 15° of arc, there shall be a minimum of three lights between the PT’s.

e) Where a taxiway ends at a crossing taxiway, place two yellow lights spaced 1.5 ft (0.46 m) in the line of the edge lights of the crossing taxiway centered on the point where the extended centerline of the ending

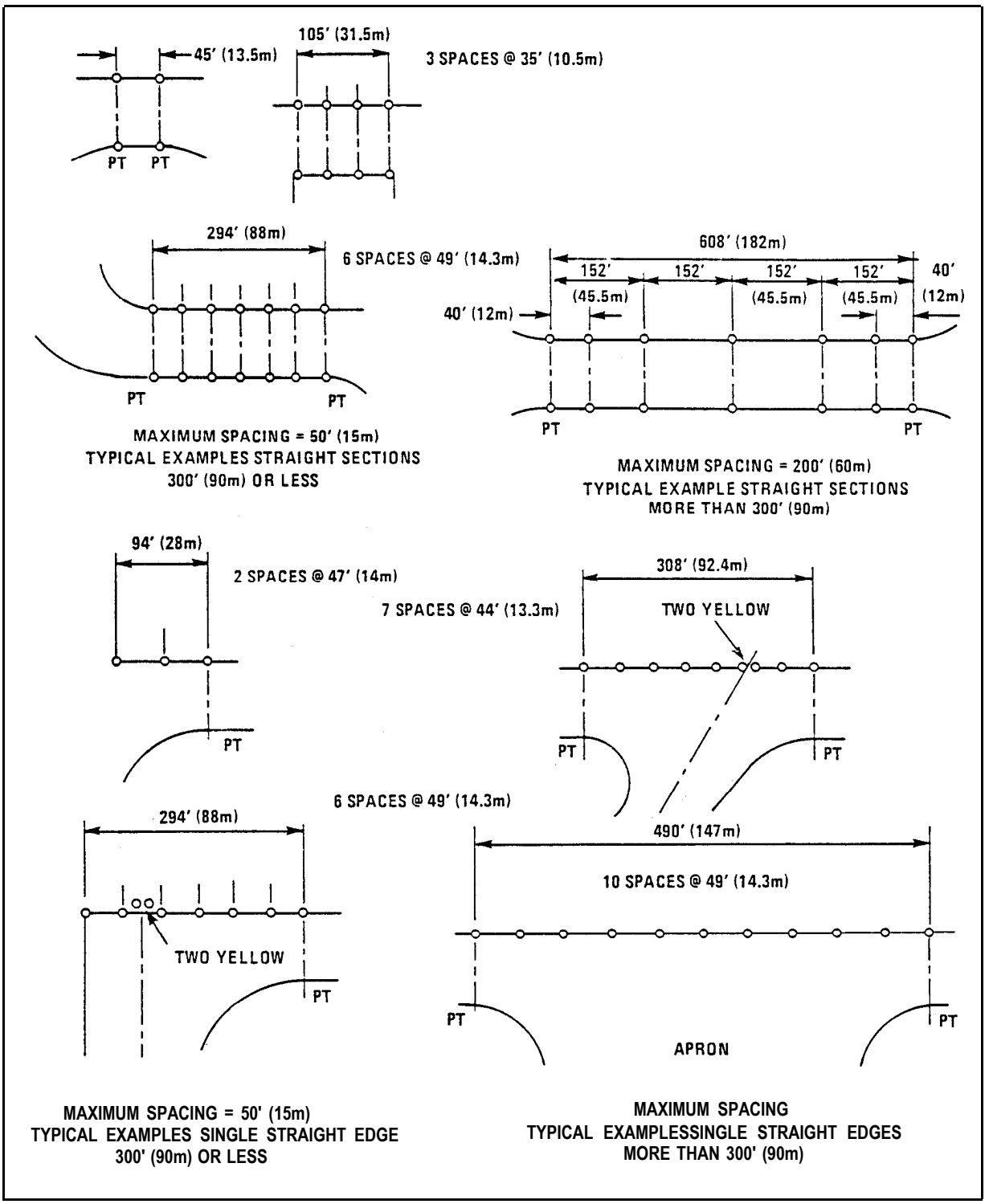


Figure 21
Taxiway Edge Lighting, Longitudinal Spacing

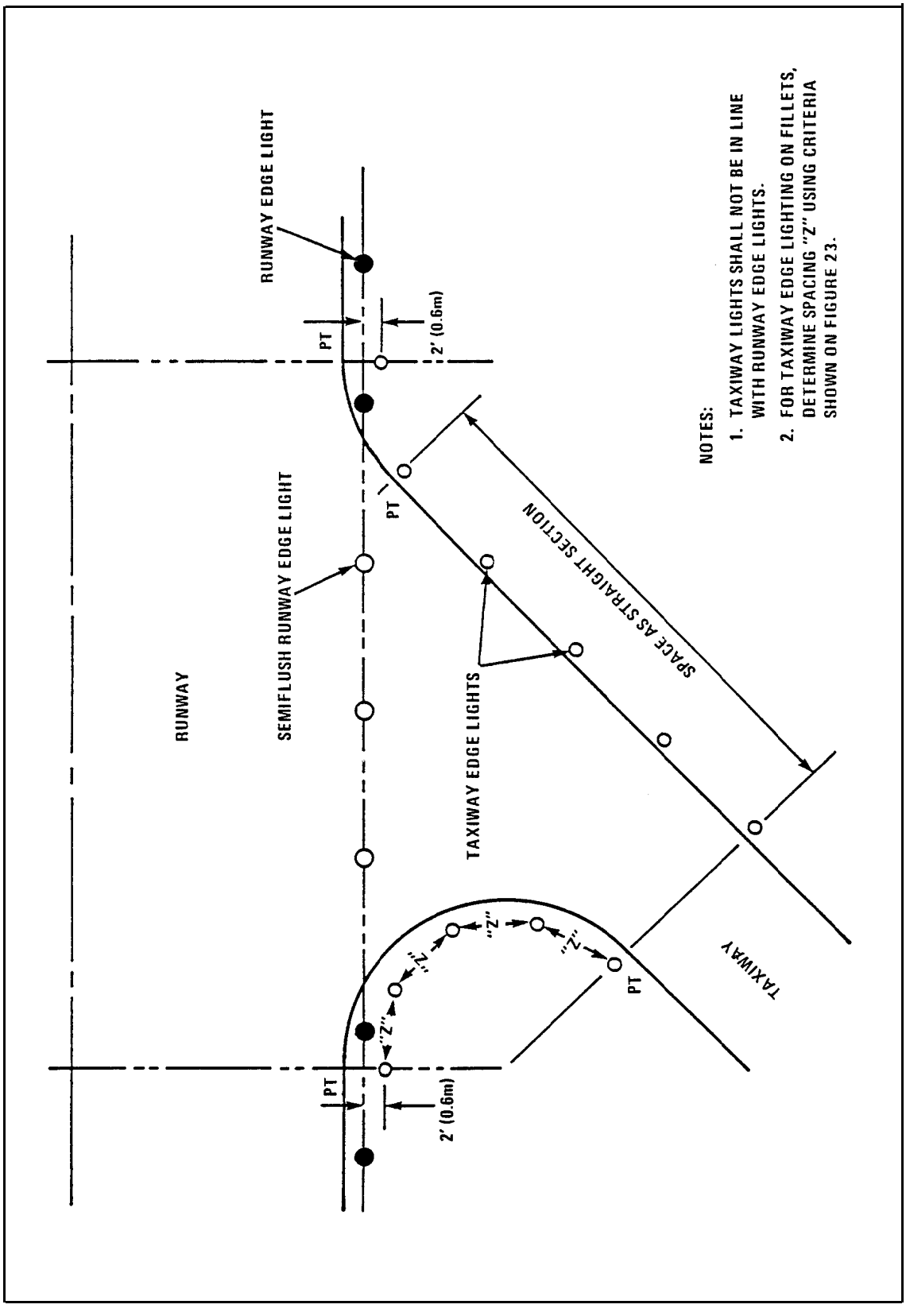
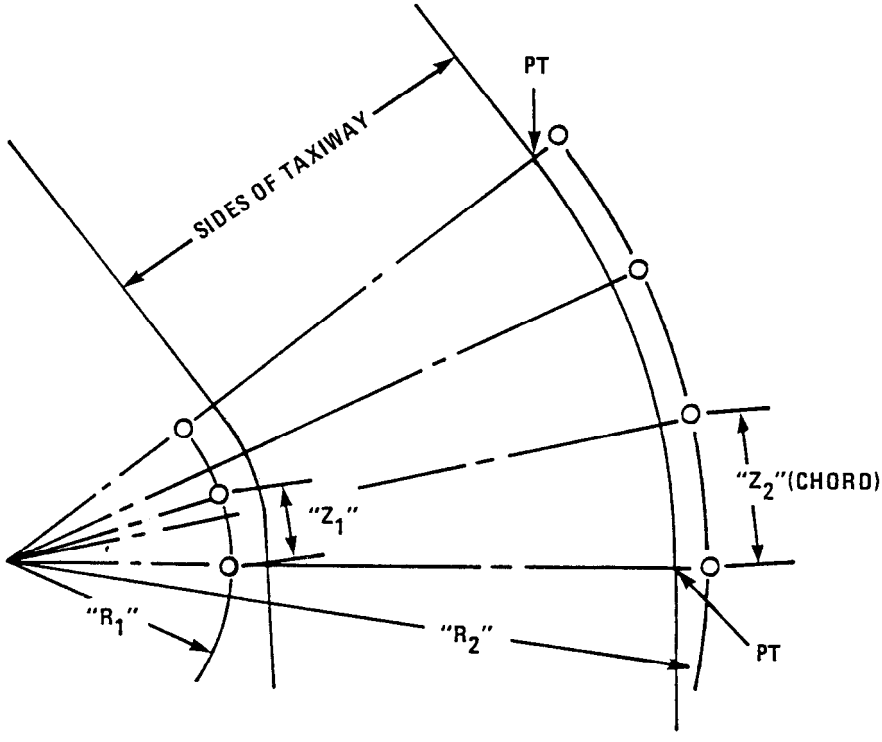


Figure 22
Taxiway Edge Lighting, Entrance-Exit Details



RADIUS R OF CURVE IN FEET (m)	DIMENSION Z IN FEET (m)
25 (7.5 m)	17.3 (5 m)
50 (15 m)	24.5 (7.5 m)
75 (22.5 m)	30 (9 m)
100 (30 m)	34.5 (10.5 m)
150 (45 m)	42.5 (13 m)
200 (60 m)	49 (15 m)
250 (75 m)	55 (16.5 m)
300 (90 m)	60 (18 m)
400 (120 m)	69 (21 m)
500 (150 m)	77 (23 m)
600 (180 m)	85 (25.5 m)
700 (210 m)	91.5 (27.5 m)
800 (240 m)	98 (29 m)
OVER 834 (250 m)	100 (30 m)

NOTES:

1. SPACE LIGHTS UNIFORMLY ON BOTH SIDES OF TAXIWAY BETWEEN POINTS OF TANGENCY (PT). DETERMINE SPACING BY DIVIDING TOTAL ARC INTO EQUAL INCREMENTS APPROXIMATING Z . ACTUAL SPACING SHALL NOT EXCEED Z BY MORE THAN 5%.
2. ON CURVES OF RADII NOT LISTED, INTERPOLATE SPACINGS FROM VALUES GIVEN.
3. ON ALL CURVES IN EXCESS OF 15 DEGREES OF ARC, THERE SHALL BE A MINIMUM OF THREE EDGE LIGHTS INCLUDING THOSE AT PT s.

Figure 23
Taxiway Edge Lighting, Spacing on Curves

taxiway intersects. If a yellow light falls within 5 ft (1.5 m) of a blue edge light, the blue light may be eliminated.

f) Adjust the longitudinal location of any light a maximum of 5 ft so as to avoid installation problems. On straight sections, the companion light should be moved a like amount, if practical, so as to maintain the relationship between them.

4.1.4 Apron Taxiways. For a taxiway that is adjacent to, or at one edge of an apron, the taxiway edge lights are placed only on the side of the taxiway furthest from the apron. Taxiways through an apron will have centerline lights in accordance with para. 4.2 instead of edge lights.

4.1.5 Tolerances. Taxiway edge lights shall be within 6 in. (152.4 mm) laterally or longitudinally of the design location.

4.1.6 Fixtures. Frangibly mounted, elevated fixtures shall be used except that where elevated lights may be damaged by jet blast, operation of an arresting barrier, or interference with aircraft operation, omnidirectional semiflush units shall be used. Elevated fixtures shall be installed not more than 14 in. (355.6 mm) above the taxiway surface except that where frequent accumulations of snow in excess of 12 in. (304.8 mm) occur they may be installed not more than 24 in. (609.6 mm) high. Elevated fixtures emit omnidirectional blue light which may produce a “sea of blue” effect which often appears to outline taxi routes which do not exist. Where this is a problem, taxiway lights may be provided with hoods to avoid the difficulty. Hoods shall not be placed on exit or entrance lights.

4.1.7 Power Requirements. Lighted taxiways require 6.6 A series circuits and are circuited so as to be independently controllable. Standby power is required only for those taxiways essential to the support of precision instrument approaches.

4.1.8 Control Requirements. Taxiway lighting circuits are to be segmented and controlled to provide the degree of flexibility required for airfield operations (see Figure 24). Remote on/off control is required for taxiway segments. Brightness control with three intensity steps is required for the system. Capability of energizing all taxiway edge lights simultaneously should be provided.

4.1.9 Equipment Requirements

4.1.9.1 Elevated Fixtures. Elevated fixtures shall be FAA AC 150/5345-46A, L-861T or MIL-L-7082D, Light, Running Marker, Elevated (Type M-1). They shall be provided with 45 W, 6.6 A lamps of a type as recommended by the manufacturer.

4.1.9.2 Semiflush Fixtures. Semiflush fixtures shall be FAA AC 150/5345-46 A, L-852E, Class 1 or 2 with 115 W, 6.6 A lamp and blue filters of MIL-L-26202D, Class B-3 with 45 W, 6.6 A lamp and blue filter satisfy the standard. Lamps shall be as recommended by the manufacturer.

4.1.10 Additional Design Guidance. Although the following publications may not be in complete agreement with this handbook, they contain significant

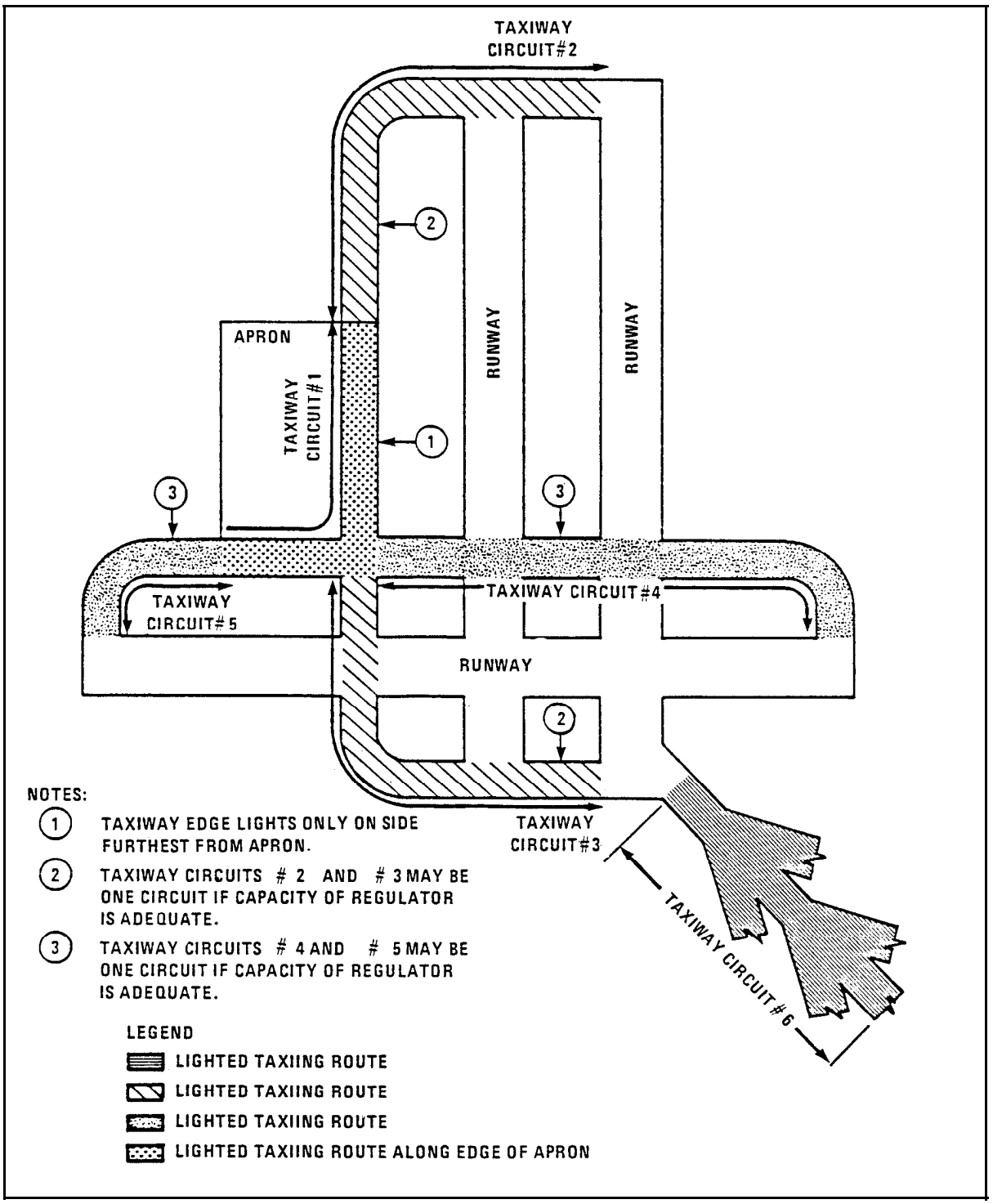


Figure 24
Typical Taxiway Circuit Layout

information to assist in the design of taxiway edge lighting systems. Where conflict exists between this handbook and the sources listed below, this handbook takes precedence:

a) NAVFAC P-272 Definitive Design Drawings:

1404287	Airfield Lighting Inset Fixture and Wiring Installation Details

b) FAA Advisory Circulars:

FAA AC 150/5340-24 Runway and Taxiway Edge Lighting Systems

c) Guide Specifications:

NFGS 16560	Guide Specification for Airfield Lighting

4.1.11 Compliance with International Military Standards

4.1.11.1 ASCC. These standards satisfy requirements of ASCC Air Standard 65/9 A, Taxiway Lighting, except for light spacings on curved taxiways with radii in excess of 1,200 ft (365.7 m) and for light intensity requirements.

4.1.11.2 NATO. These standards satisfy the requirements of NATO STANAG 3316, Airfield Lighting, except for light spacings on curves with radii between 150 ft (45.7 m) and 800 ft (244 m) and radii above 1,200 ft.

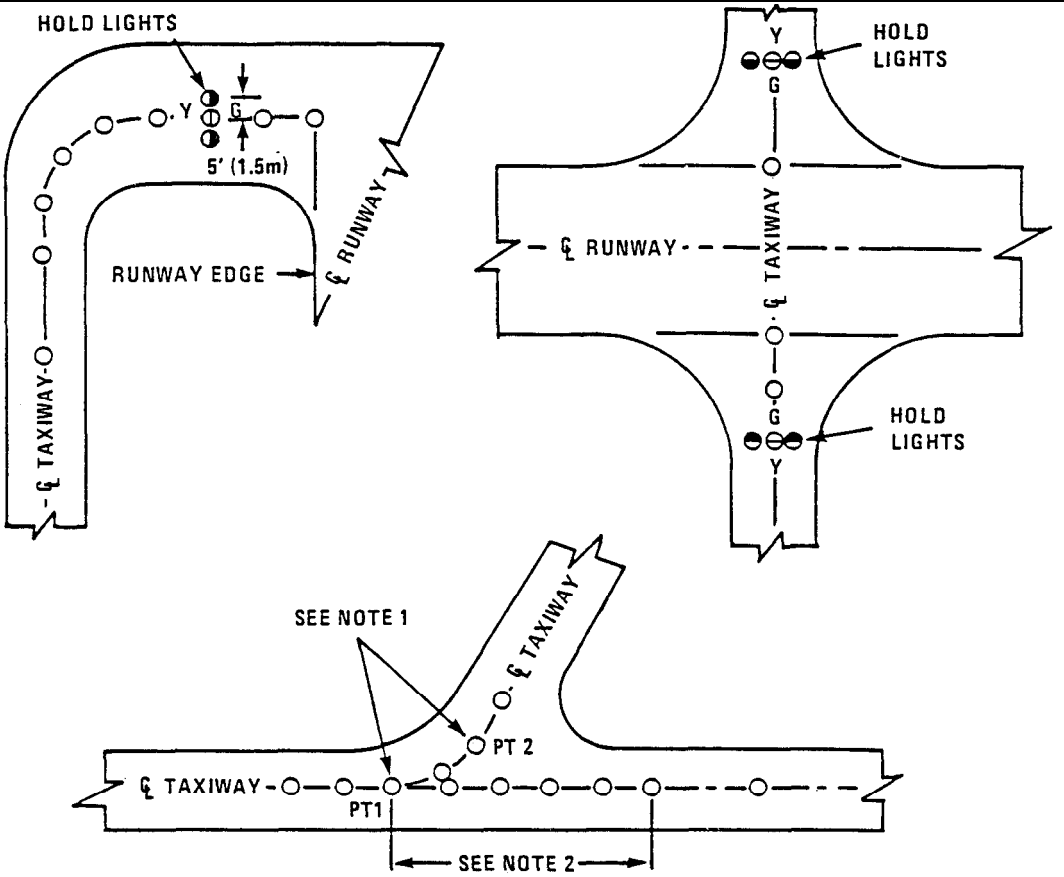
4.2 Taxiway Centerline Lights (Cat. Code 136-50)

4.2.1 Description. Taxiway centerline lights are a system of green semiflush lights installed along taxiway centerlines to augment the alignment information provided by the taxiway edge lights. While they may be installed at any airfield, they are required on all taxiways intended to support the Category II operations. They are used in lieu of taxiway edge lights on taxiways sections which cross aprons, ramps, or other large paved areas. They are also required on high speed runway exits (refer to para. 4.3).

4.2.2 Configuration. Taxiway centerline lights are installed in smooth lines along the taxiway centerline. To avoid construction joints the lines of lights may be uniformly offset a maximum of 2 ft (0.6 m) from the centerline. The spacing of the lights shall be determined as follows:

a) Place a light at each holding position, at each PT of curved sections, at each taxiway end, at each intersection with a runway edge or apron, and at the PT's of all fillets. Where taxiways cross, place a light at the intersection of the centerlines.

b) Place lights uniformly spaced between the points defined above, along all straight and curved sections of taxiway. The uniform spacing shall approach but not exceed the criteria shown in Figure 25. The location of individual lights may be adjusted along the line of lights a maximum of 2 ft (0.6 m) to avoid construction problems.



LONGITUDINAL SPACING CRITERIA

		CAT. II IFR	ALL OTHER
NOMINAL		50'(15 m)	100'(30 m)
AT INTERSECTIONS (SEE NOTE 2)		50'(15 m)	50'(15 m)
CURVES (SEE NOTE 1)	RADIUS LESS THAN 400' (120 m)	12.5'(3.75m)	25'(7.5 m)
	RADIUS 400' to 1200' (360 m)	25'(7.5 m)	50'(15 m)
	RADIUS GREATER THAN 1200' (360 m)	50'(15 m)	100'(30 m)

LEGEND

G
⊖ BIDIRECTIONAL, GREEN AND YELLOW
Y

○ BIDIRECTIONAL, GREEN
◒ UNIDIRECTIONAL, YELLOW

NOTES:
1. LOCATE LIGHTS AT PT1 AND PT2, AND SPACE INTERMEDIATE LIGHTS EQUALLY ALONG SELECTED CURVE IN COMPLIANCE WITH SPACING CRITERIA.
2. SPACE LIGHTS EQUALLY BETWEEN PT1 AND HOLD LIGHTS.
3. RUNWAY AND TAXIWAY EDGE LIGHTS NOT SHOWN.

Figure 25
Taxiway Centerline Lighting

c) At taxiway intersections, place lights along an arc drawn tangent to the centerlines of the taxiways (or lines of lights) in the direction of all aircraft turns. Where aircraft turns are not anticipated the arc of lights may be omitted to reduce confusion. The minimum clearance to the inner edge of either taxiway shall be equal to one-half the width of the narrower taxiway. The largest radius that will provide the clearance should be selected for the arc of lights. Except as provided for runway exits (refer to para. 4.3), no taxiway centerline lights shall be installed on runway surfaces.

4.2.3 Tolerances. Taxiway centerline lights shall not be more than 3 in. (76.2 mm) off the designated line of lights and not more than 6 in. (150 mm) from the designated location along the line of lights.

4.2.4 Fixtures. All fixtures are semiflush and shall not protrude more than 0.5 in. (12.7 mm) above the pavement. They shall be bidirectional green except as follows:

a) At crossing taxiways, the light at the intersection shall be omnidirectional yellow.

b) On taxiways where the aircraft movement is in one direction only, the lights may be unidirectional facing the oncoming aircraft.

c) Where hold lights are installed, the centerline light at the hold line shall show yellow toward the holding aircraft.

4.2.5 Power Requirements. Taxiways with centerline lights require a power system circuited so as to be independently controllable. Standby power is required only for those taxiways essential to the support of precision instrument approaches. Transfer shall be accomplished within 15 seconds.

4.2.6 Control Requirements. Taxiway lighting circuits shall be segmented and controlled to provide the degree of flexibility required for airfield operations (see Figure 24). Remote on/off control is required for taxiway segments. Brightness control with three intensity steps is required for the system.

4.2.7 Equipment Requirements.

4.2.7.1 Fixtures. Fixtures shall meet FAA AC 150/5345-46A, L-852, Class I or II. These fixtures may be ordered for direct inset, for mounting on special shallow bases, or for mounting on base housings. Fixtures are selected by type depending on application as follows:

a) Straight Centerline Sections. Except for Cat. III operations, use Type L-852A with green/green filters. At hold bars the filter facing the holding aircraft shall be yellow. For Cat. III use Type L-852C.

b) Curved Centerline Sections. Except for Cat. III operations, use Type L-852B on curved sections. Where small radius turns require aiming along a chord for proper viewing, two fixtures may be used. For Cat. III use Type L-852D.

c) Taxiway Intersections. At crossing taxiways use Type L-852E, except for Cat. III use Type L 852-F.

4.2.7.2 Lamps. Lamps shall be as recommended by the manufacturer to meet the requirements of FAA AC 150/5345-46. Various manufacturers may meet the requirements using different lamps. In the interest of energy conservation, the use of lower wattage lamps is preferred.

4.2.8 Additional Design Guidance. Although not in complete agreement with this handbook, the publications listed below contain significant information to assist in the design of taxiway centerline lighting systems. Where differences occur, this handbook takes precedence:

a) NAVFAC P-272 Definitive Design Drawings:

1404287	Airfield Lighting Inset Fixture and Wiring Installation Details

b) FAA Advisory Circulars: FAA AC 150/5340-19 Taxiway Centerline Lighting System

c) Guide Specifications:

NFGS 16560	Guide Specification for Airfield Lighting

4.2.9 Compliance with International Military Standards

4.2.9.1 ASCC. These standards meet the requirements of ASCC Air Standard 65/9, Taxiway Lighting.

4.2.9.2 NATO. Theses standards meet the requirements of NATO STANAG 3316, Airfield-Lighting.

4.3 Runway Exit Lights (Cat. Code 136-50)

4.3.1 Description. Runway exit lights may be added to long radius (high speed) exit taxiways, or to short radius (low speed) taxiway exits where there are visual problems. The configuration for each are different, but in each case they are supported with taxiway edge lights installed in accordance with para. 4.1.

4.3.1.1 Long-Radius Exits. Long-radius exit lights are installed on exits with radii in excess of 1,200 ft (365.7 m). They consist of a line of unidirectional green taxiway centerline lights. The line which begins at a point which is a maximum of 3 ft (0.91 m) off the runway centerline and 200 ft (61 m) before the beginning of the taxiway centerline curve. The line of lights runs parallel to the runway to the point of beginning of the taxiway centerline curve and follows the taxiway centerline curve to a point which is a minimum of 200 ft beyond the beginning of the straight portion of the taxiway. They shall be uniformly spaced at a distance not to exceed 50 ft (15.2m) (see Figure 26).

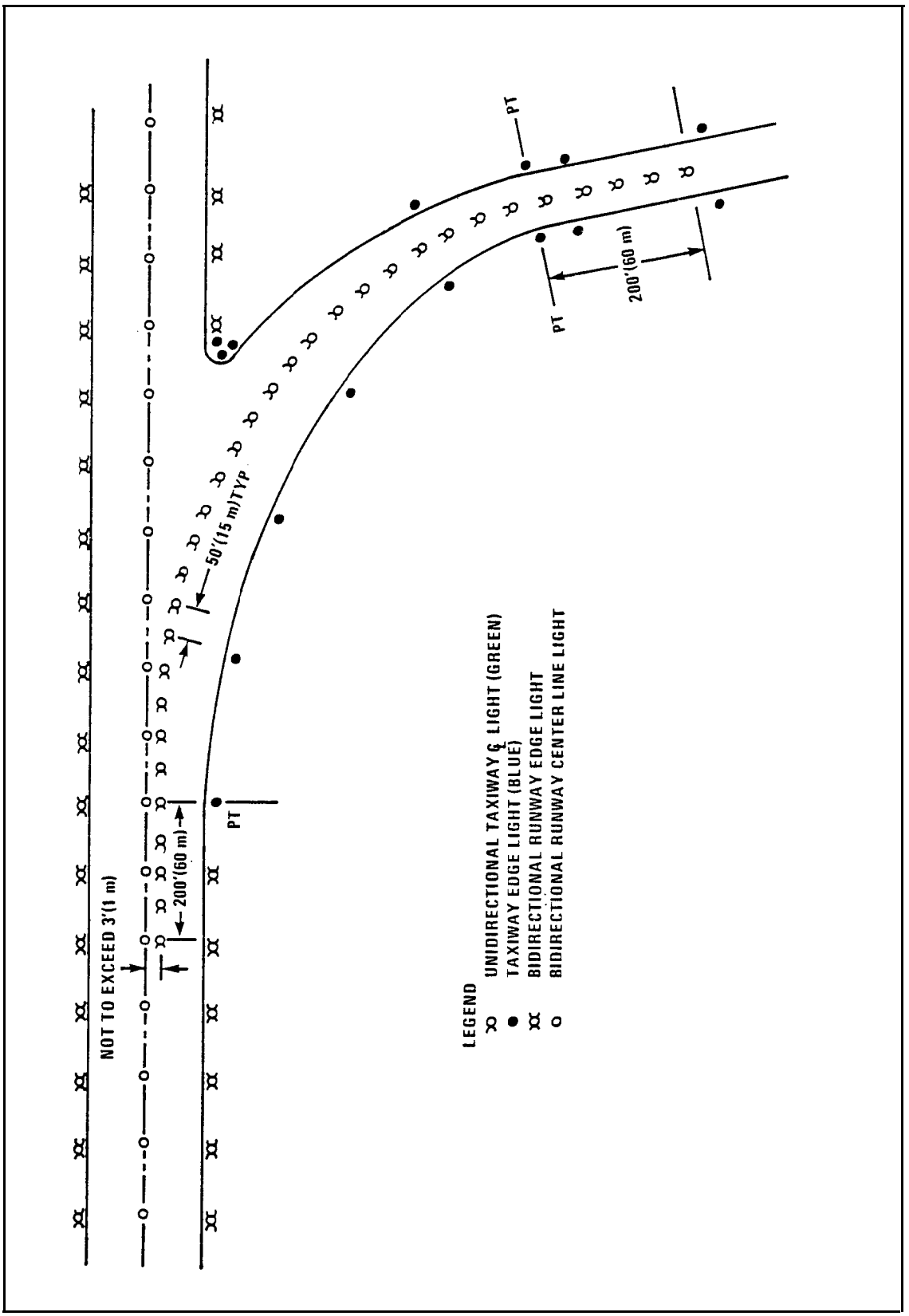


Figure 26
Long Radius (High Speed) Runway Exit Lighting

4.3.1.2 Short-Radius Exits. Short-radius exit lights consist of a line of green taxiway centerline lights. The line begins at a point which is not more than 3 ft (0.91 m) off the runway centerline on the near side and is the PT of the exit curve. The radius of the curve should be the largest that will provide a minimum clearance to the pavement edge equal to one-half the width of the taxiway centerline and thence along the taxiway centerline for a minimum of 200 ft (60 m). The spacing between the lights shall not be greater than 25 ft (7.6 m), see Figure 27.

4.3.2 Adjustments and Tolerances. Adjustments and tolerances shall be as provided in para. 4.2 for taxiway centerline lights.

4.3.3 Fixtures. Runway exit lights are semiflush unidirectional fixtures with no part of the fixture extending more than 0.5 in. (12.7 mm) above the surrounding pavement. All fixtures located within 35 ft (10.6 m) of the runway centerline shall be of the hook-resistant type. All centerline lights in high speed exits shall be unidirectional facing the exiting aircraft. All centerline lights on low speed exits shall be unidirectional, except that in the straight portion those lights not on the runway surface may be bidirectional if the taxiway is intended for bidirectional use. The fixtures shall be horizontally aimed as indicated in paras. 4.3.3.1 through 4.3.3.2.

4.3.3.1 High-Speed Exit Lights. All hook-resistant lights shall be aimed for the axis of the beam to intersect the line of exit light 200 ft along the exit centerline. The remaining lights along the curved portion shall be aimed tangent to the curve, and the lights along the straight portion shall be aimed along the taxiway centerline.

4.3.3.2 Low-Speed Exit Lights. All lights in the curved portion shall be aimed tangent to the exit centerline, and all lights in the straight portion shall be aimed along the taxiway centerline.

4.3.4 Power Requirements. Runway exit lights are powered from 6.6 A series circuits. They may be circuited so as to permit independent control or may be connected to and controlled with the associated taxiway lights. Runway exit lights require standby power with a response time equal to that of the associated runway.

4.3.5 Control Requirements. Runway exit lights require on/off control and brightness control with three intensity steps.

4.3.6 Equipment Requirements

4.3.6.1 Hook Resistant Fixtures. There is no qualifying specification for these fixtures. The fixture generally used is referred to as an L-852N-2 since it is a derivative of the FAA AC 5345/46, Type L-852 fixture. The L-852N-2 is a ruggedized version which has been designed specifically for USN application. Crouse Hinds is the only known manufacturer. The fixture is available in Types V, VI, VII, and VIII. Types V and VI are designed to be inset directly in pavement and types VII and VIII are designed to be installed on mounting bases. Lamps are to be 65 W of a type recommended by the manufacturer.

4.3.6.2 Other Fixtures. All other fixtures shall be as provided for taxiway centerline lights in para. 4.2.

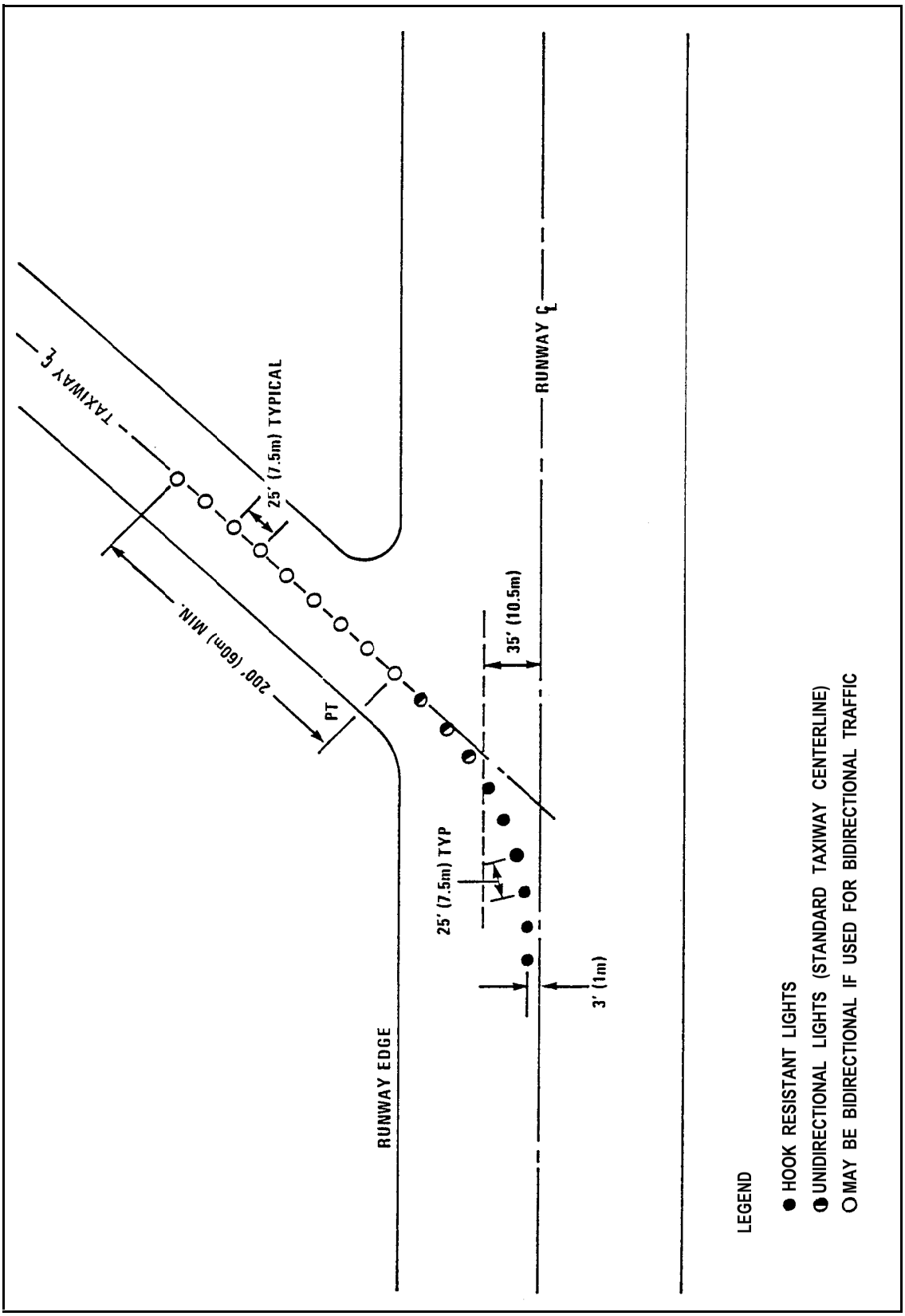


Figure 27
Short Radius (Low Speed) Runway Exit Lights

4.3.7 Additional Design Guidance. Although not in complete agreement with this handbook, the publications listed below contain significant information to assist in the design of runway exit lighting systems:

a) NAVFAC P-272 Definitive Design Drawings.

1404287	Airfield Lighting Inset Fixture and Wiring Installation Details

b) FAA Advisory Circulars

FAA AC 150/5340-19 Taxiway Centerline Lighting System

c) Guide Specifications

NFGS 16560	Guide Specification for Airfield Lighting

4.3.8 Compliance with International Military Standards

a) ASCC. These standards meet the requirements of ASCC Air Standard 65/9, Taxiway Lighting.

b) NATO. These standards meet the requirements of NATO STANAG 3316, Airfield Lighting.

4.4 Taxiway Hold Lights (Cat. Code 136-50)

4.4.1 Description. Taxiway hold lights consist of semiflush yellow lights installed across the taxiway to identify holding positions.

4.4.2 Configuration. Hold lights are three semiflush lights spaced 5 ft (1.5 m) on center installed parallel to and within 3 ft (0.91 m) of the hold markings at the holding position. The group of lights is centered within 12 in. (50.8 mm) of the taxiway centerline or on the centerline lights if installed (see Figure 25). Hold lights emit unidirectional yellow light toward the holding aircraft. When installed in conjunction with taxiway centerline lighting, the center light shall be bidirectional green/yellow with the green light toward the runway end of the taxiway. When installed on a very wide taxiway, the number of lights may be increased to five.

4.4.3 Fixtures, Power and Control Requirements. Fixtures shall be as required for taxiway centerline lights and shall be powered and controlled by the associated taxiway lighting system.

4.4.4 Additional Design Guidance. Although not in complete agreement with this handbook, the publications listed below contain significant information to assist in the design of hold lighting systems:

a) NAVFAC P-272 Definitive Design Drawings:

1404287	Airfield Lighting Inset Fixtures and Wiring Installation Details

b) FAA Advisory Circulars:

FAA AC 150/5340-19 Taxiway Centerline Lighting Systems

c) Guide Specifications:

NFGS 16560 Guide Specification for Airfield Lighting

4.4.5 Compliance with international Military Standards. ASCC and NATO Standards contain no comparable systems.

4.5 Taxiway Guidance Signs (Cat. Code 136-50)

4.5.1 Purpose. Taxiway guidance signs are installed at airfields to guide pilots of aircraft to destinations, for ground control of aircraft, and for safety of ground operations. The extent of guidance and control provided will depend upon the complexity of the airfield layout, volume of traffic, and visibility.

Airports with complex layouts require more precise taxiing and control guidance because the pilot must make more decisions in choosing the proper destination route. Also, there is a greater possibility of collision at intersections with other aircraft. Traffic volume alone may be justification for signs to promote safe taxiing.

As traffic increases, more signs are needed to simplify and reduce the extent of information that must be transmitted by radio. Regardless of the complexity of the airport layout or the extent of the traffic volume, signs are required when visibility is poor, both to provide the necessary guidance and to insure safety of operations.

4.5.2 Sign Classifications. Signs provide various types of information to pilots and are classified as either mandatory or informative.

4.5.2.1 Mandatory Signs. A mandatory sign is provided when an instruction must be followed. Typical mandatory signs are stop signs, no-entry signs, holding positions signs, and taxiway or runway intersection signs when used in lieu of a stop or a holding position sign. A mandatory sign has a white inscription on a red background.

4.5.2.2 Informative Signs. All other signs are classed as informative signs. They are used as required to indicate specific location, or destination on an aircraft movement area, or to indicate other useful information. An informative sign has, preferably, a black inscription on a yellow background but may, for the sake of consistency or where airfield lighting tone down is a consideration, have a yellow inscription on a black background.

4.5.3 Sign Configurations

4.5.3.1 Standard Signs. Taxiway guidance signs supporting night and instrument operations shall be internally illuminated. They may be single- or double-faced. Marking and illumination shall be sufficient to make the sign readily discernible at night at a distance of 800 ft (243.8 m) under a

meteorological visibility of 3,000 ft (914.4 m) and clearly legible at a minimum distance of 500 ft (152 m) day or night. Color schemes for signs shall be as given in para. 4.5.2. Taxiway guidance signs shall be a minimum of 24 in. (609.6 mm) high with a minimum legend height of 15 in. (381 mm), see Figure 28. The length of the sign will be determined by the number of characters required for the message. The signs may be fabricated as a single unit or in sections. Signs shall be located no less than 25 ft (635 m) from the edge of the taxiway or runway. The overall height of the sign should be no more than 24 in. above the adjacent taxiway surface if located between 25 and 35 ft (7.6 and 10.6 m) from the edge of the taxiway. Signs located 35 ft from the taxiway edge may be 30 in. (762 mm) above the taxiway surface. In no case shall the overall mounting height be greater than 5 ft (1.5 m) above the ground at the sign location. All signs shall be frangible mounted.

4.5.3.2 Nonstandard Signs. Special circumstances may dictate that a standard sign is unsuitable for a particular sign location in which case guidelines contained in FAA Advisory Circulars AC 150/5345-4 and AC 150/5340-18, Standards for Airport Sign Design, shall be followed in designing and locating nonstandard signs.

4.5.4 Taxiway Guidance System Configuration. There are no standard configurations for taxiway guidance systems. Before designing a taxiway guidance sign system, make a thorough study of the designed taxiway layout drawings with local traffic controllers and the operational groups using the airfield. The number of signs used should be kept to a minimum because of possible hazards to the aircraft.

4.5.4.1 Destination Signs, General. Destination signs shall be provided for both inbound and outbound taxiing routes, where required, see Figure 29. Arrows used in destination signs should consist of chevrons with or without a shaft which is separated from the chevron arrowhead.

4.5.4.2 Outbound Destination Signs. Mark outbound routes from their beginning to their termination point with destination signs showing the appropriate runway numbers. Outbound routes usually begin at the entrance of a taxiway from an apron area. Its termination point will be at the takeoff end of the appropriate runway. Outbound destination signs may show more than one runway destination number if the direction of travel of a taxiing route is the same to all the runway destinations shown in the sign. In such cases, separate any pair of runway destination numbers by a circular dot (see Figure 29).

4.5.4.3 Inbound Destination Signs. Mark inbound routes from their beginning with destination signs showing the appropriate symbols. Inbound routes usually begin at the entrance to a taxiway from a runway. Mark inbound traffic routes at the beginning with destination areas on an airport. Provide destination signs giving directions to specific areas at appropriate intersections along the inbound traffic route. Typically, signs installed at the entrance to a taxiway from a runway show “RAMP,” “E RAMP," “MIL,” etc. Install destination signs at other locations along the inbound traffic routes and in the vicinity of the general destination area with symbols which show the direction to specific areas, such as “GATE 3,” “VSTR,” etc. This requirement is provided as a general guide and may be varied where

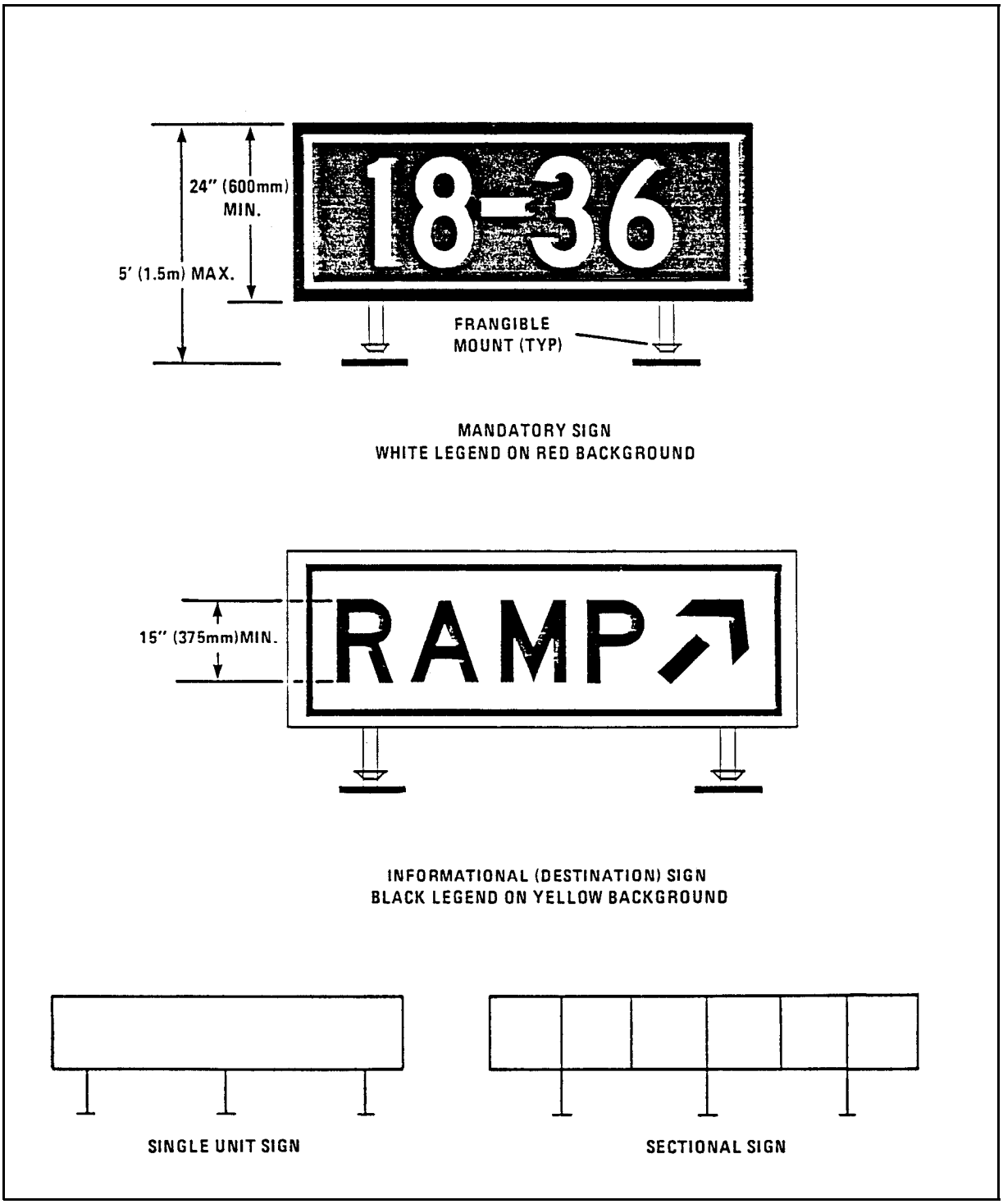


Figure 28
Taxiway Guidance Signs

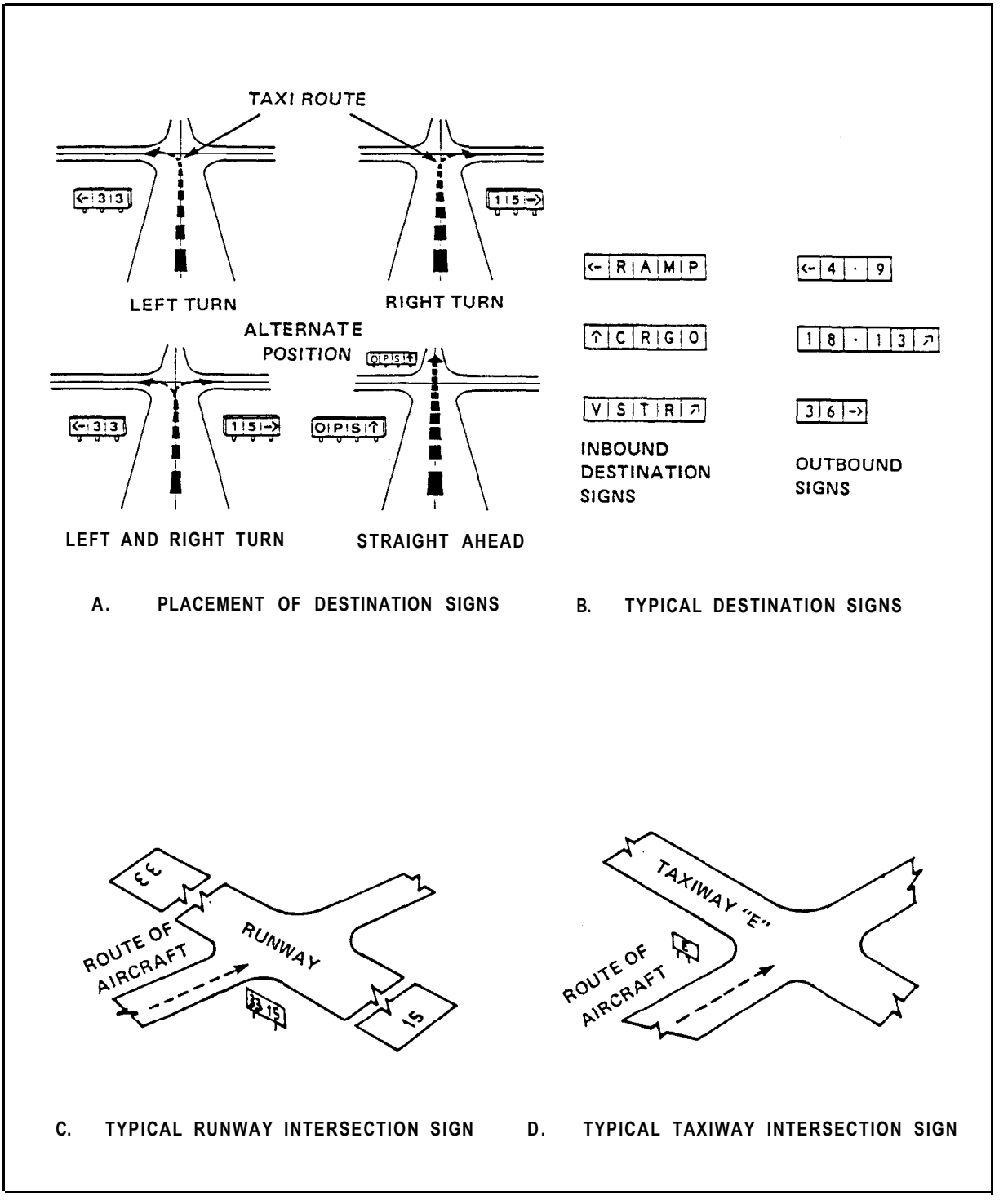


Figure 29
Typical Locations for Destination and Intersection Signs

necessitated by local conditions due to variations in airport layout and ground traffic conditions. Some terms and abbreviations which are commonly used and understood without misinterpretations are as follows:

SIGN	MEANING
RAMP	General parking, servicing, and loading areas
PARK	Aircraft parking only areas
CIVIL	Civilian areas of joint-use airports
MIL	Military areas of joint-use airports
CARGO	Freight or cargo handling areas
INTL	International areas
RUNUP	Runup areas
ACP	Altimeter check point
VCP	VOR check point
OPS	Operations areas
VSTR	Visitors area
FUEL	Refueling area
RUNWAY NUMBERS	Holding point at intersection with runway
INST	Instrument holding position
GATE	Passenger Landing or Unloading Area
HGR	Hangar Area

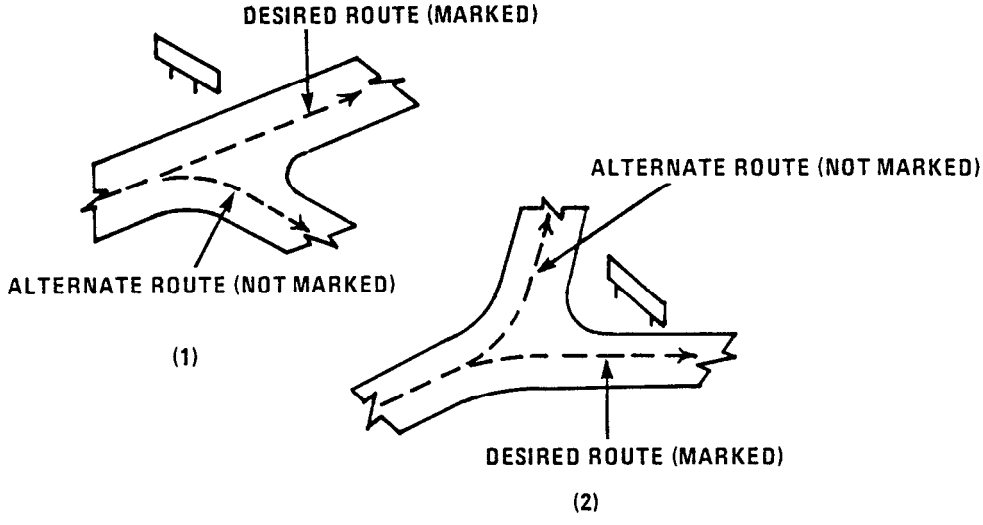
4.5.4.4 Intersection Signs, General. Provide intersection signs with appropriate numbers or letters at the intersections of a runway, taxiway, or of a taxiway with an apron, to inform the pilot that he or she is approaching an intersection and to identify the intersecting operational surface (see Figures 29c and 29d).

4.5.4.5 Runway Intersection Signs. Provide numbers and letters assigned to each end of a runway on runway intersection signs to identify a runway. Separate the assigned numbers and letters shown on the intersection sign by a dash, such as "33-15." Indicate by arrangement of the runway numbers of the sign the direction to the corresponding numbered ends of a runway. For example, "33-15" indicates to the pilot that the “33” end of the runway is to the left, and the “15” end of the runway is to be right (see Figure 29c).

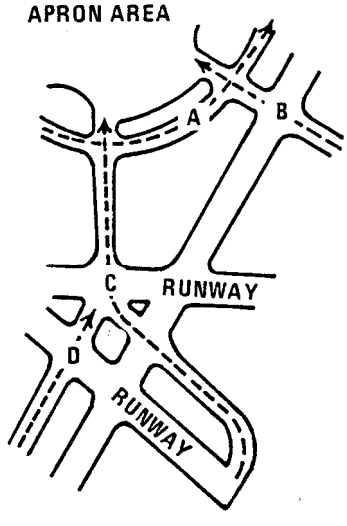
4.5.4.6 Taxiway Intersection Signs. Use letters to identify taxiways. Use the same letters to identify an entire taxiway, even though it is composed of short sections caused by intersections of other taxiways or runways. Use double letters to identify taxiways where an airfield has a larger number of taxiways than there are usable single letters available, such as “AA” (see Figures 29d and 30).

4.5.4.7 Alternate Routes. At intersections of junctions or runways, taxiways, or runways and taxiways, where the possibility of alternate routes to a particular destination exists from a given direction of travel, the destination sign shall indicate only one route to follow (see Figure 30).

4.5.4.8 Holding Position Signs. Holding positions generally are either instrument holding positions or runway holding positions and are marked as such in accordance with the requirements of DM-21, Airfield Pavements Design, Chapter 6. Instrument holding positions will be identified with a holding position sign using the letters “INST.” Runway holding positions will be



ALTERNATE ROUTES



ASSIGNMENT OF LETTERS TO TAXIWAYS

Figure 30
Alternate Taxiway Routes and Taxiway Identification

identified by runway intersection signs. Signs marking holding positions are mandatory signs.

4.5.5 Sign Locations

4.5.5.1 General Information. Because of the variety of taxiway intersections and information which may be required, it is difficult to establish a firm rule for the location of signs. A good general practice is to locate intersection signs on the near side of intersections. A sign indicating a destination is placed on the far side of the intersection on the same side of the taxiway as the direction to the location indicates. If the destination is straight ahead, the sign may be located on either side. Location signs without arrows should be located on the left side of the taxiway. Mandatory signs shall be located on the left or on both sides of the taxiway (see Figures 29 and 31).

4.5.5.2 Holding Position Signs. Install holding position signs on the left or on both ends of a hold line marking. Where the hold line marking exceeds 150 ft (45.7 m) in length, a sign should be installed at each end of the hold line marking. Holding position signs are required adjacent to runways used as taxiways to identify the critical areas, as hold line markings are not installed across usable runways.

4.5.6 Power and Control. Taxiway guidance signs will be connected to and controlled with the associated taxiway lighting circuits. Where intensity controls are used on taxiways, provision must be made for the signs to operate at a minimum of 80 percent of the maximum brightness of the signs for all intensity settings of the taxiway lights.

4.5.7 Equipment Requirements

4.5.7.1 Signs. Guidance signs shall meet FAA AC 150/5345-44D, Taxiway and Runway Signs. Type L-858Y is used for informational signs and Type L-858R is used for mandatory signs (Size 2 and 3 may be used). The size is to be determined by the location, viewing distance and operational requirement. The style and class of the sign is dictated by the power source and operational climate. Any required power adaptors to connect the sign to the power circuit shall be provided by the manufacturer with the sign.

4.5.8 Additional Design Guidance.

a) NAVFAC P-272 Definitive Design Drawings: None

b) FAA Advisory Circulars:

FAA AC 150/5340-18 Standards for Airport Sign Systems

c) Guide Specifications:

NFGS 16560 Guide Specification for Airfield Lighting

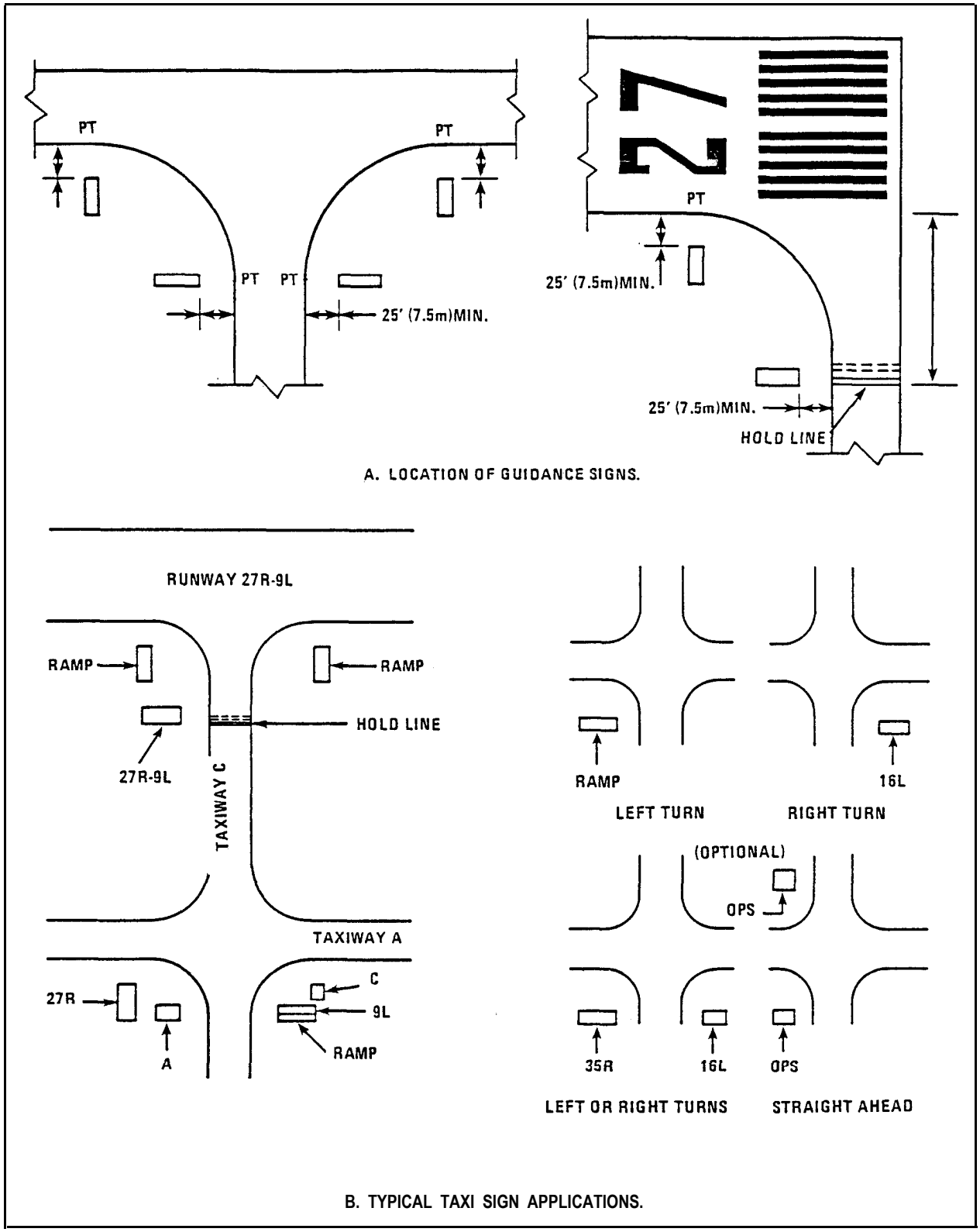


Figure 31
Typical Locations and Siting for Taxiway Guidance Signs

4.5.9 Compliance with International Military Standards

4.5.9.1 ASCC. ASCC standards do not comply with ASCC Air Standard 65/17, Airfield Signs, for taxiway signs with regard to color scheme of all signs or shape of holding positions signs.

4.5.9.2 NATO. NATO standards do not comply with NATO STANAG 3316, Airfield Lighting, for taxiway signs with regard to color scheme of all sings or shape and color of holding position signs. it is anticipated that these standards will satisfy the seventh edition of NATO STANAG 3316.

Section 5: SIMULATED CARRIER, WHEELS WATCH AND RUNWAY WAVEOFF LIGHTING

5.1 Simulated Carrier Deck Lighting (Cat. Code 136-36)

5.1.1 Description. Simulated carrier deck lights are installed on a runway with their associated simulated carrier deck markings to provide a training and practice environment for carrier deck approaches and landings.

5.1.2 Configuration. They consist of a line of deck centerline lights and 2 lines of deck edge lights which run longitudinally and 2 sets of athwartship lights which mark the beginning and end of the deck landing area. A Landing Signals Officer (LSO) Station is also required (see Figure 32).

5.1.2.1 Deck Centerline Lights. Deck centerline lights consist of 18 lights installed on a line which is 61.75 ft (18.82 m) from the left runway edge as viewed from the approach. The first light is located 320 ft (97.5 m) from the runway threshold and the remainder are spaced 45 ft (13.7 m) apart thereafter.

5.1.2.2 Deck Edge Lights. Deck edge lights are in two lines of 16 lights installed 35 ft (10.6 m) either side of the line of deck centerline lights. The first light in each line is located 320 ft from the runway threshold and the remainder are spaced 45 ft apart thereafter.

5.1.2.3 Ramp Athwartship Lights. Ramp athwartship lights are a transverse line of 12 lights spaced 5 ft (1.5 m) apart and centered on the line of deck centerline lights. This line of lights is located 320 ft from the runway threshold.

5.1.2.4 Forward Athwartship Lights. Forward athwartship lights are a transverse line of 10 lights centered on the line of the deck centerline lights. This line of lights is located 1,085 ft (330.7 m) from the runway threshold.

5.1.2.5 LSO Station. The LSO station consists of an area 44 ft (13.4 m) wide extending from the runway edge outboard for a distance of 60 ft (18.29 m) which has been graded for drainage and stabilized for light vehicular traffic. The center of the area is located 115 ft (35 m) upwind from the line of the ramp athwartship lights and 62 ft (19 m) outboard of the simulated carrier deck edge lights. All control lines for the LSO are terminated at the handhole.

5.1.3 Adjustments. Where interference with construction joints or other installation problems occur, lights may be adjusted longitudinally for a distance of not more than 2 ft (0.6 m). Companion lights in the row must be moved the same amount to maintain lateral alignment.

5.1.4 Fixtures. All simulated carrier deck fixtures are semiflush, unidirectional white lights and are of a type resistant to tailhook damage. All lights are aimed parallel with the simulated carrier deck centerline and toward the approaching aircraft.

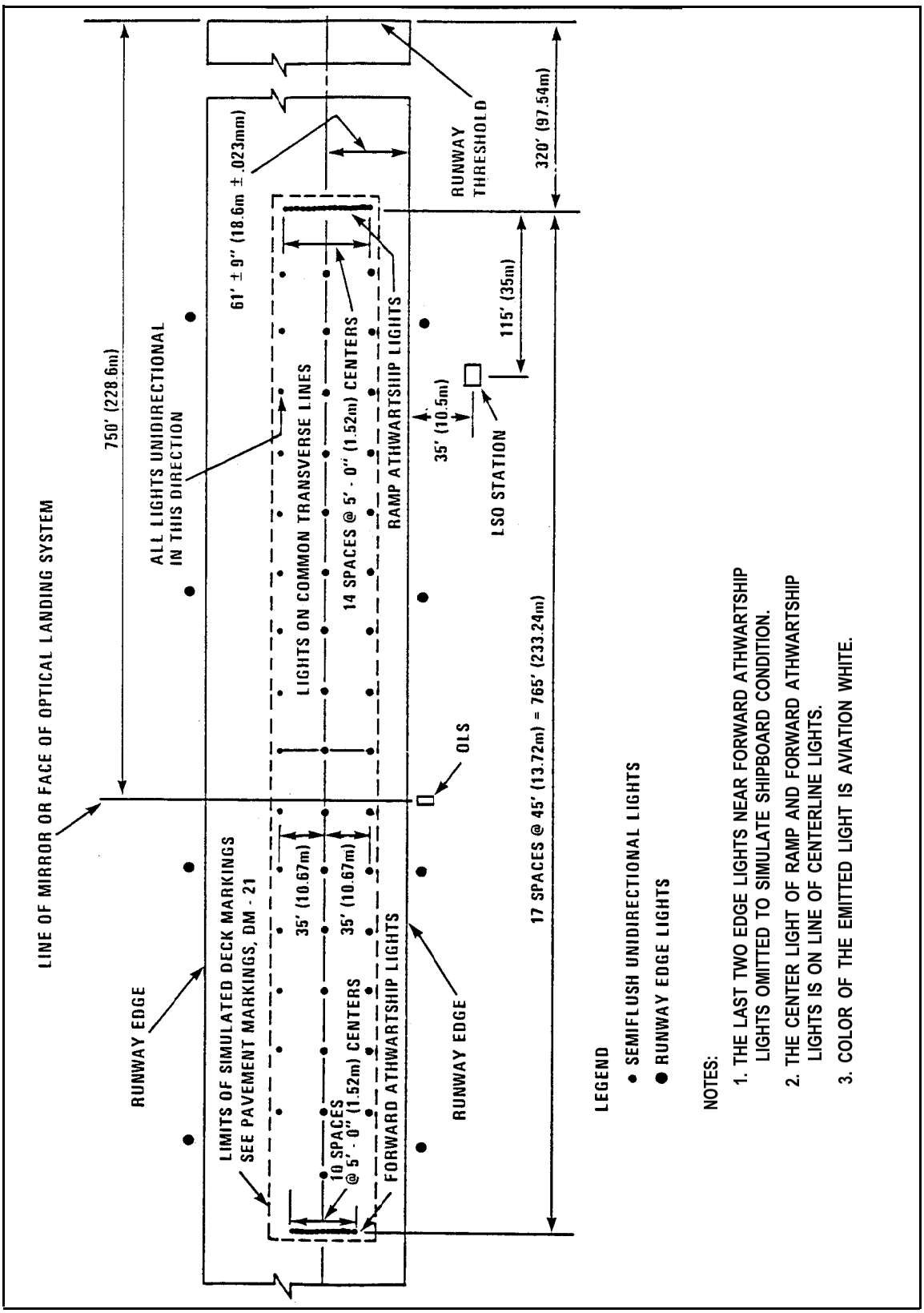


Figure 32
Simulated Carrier Deck Lighting

5.1.5 Electrical Requirements. Simulated carrier deck lighting systems are usually connected to 6.6 A circuits. They may be connected to 20 A circuits with 20 A/6.6 A isolation transformers.

5.1.6 Control Requirements. Simulated carrier deck lighting requires on/off control and brightness control with a minimum of three intensity steps. The controls must be interconnected with the controls for the associated runway lights so as to prohibit simultaneous operation of both systems and to provide override capability for operation of the runway lights in an emergency. The operating controls are required at the LSO station and the override capability is required at the control tower.

5.1.7 Equipment Requirements

5.1.7.1 Fixtures. There are no qualifying specifications for fixtures. The fixture generally used is referred to as an L-852N since it is a derivative of the FAA AC 150/5345-46, Type L-852 fixture. The L-852N is a ruggedized version which is designed specifically for USN application. Crouse Hinds Corporation is the only known manufacturer. The fixture is available in Types V, VI, VII, and VIII. Types V and VI are designed to be inset directly in pavement and the last Types VII and VIII are for installation on mounting bases. Lamps are to be 45 W of a type recommended by the fixture manufacturer.

5.1.8 Additional Design Guidance. Although the following publications may not be in complete agreement with this handbook, they contain significant information to assist in the design of simulated carrier deck lighting systems. Where conflict exists between this handbook and the sources listed below this handbook takes precedence:

a) NAVFAC P-272 Definitive Design Drawings:

1404287	Inset Fixture and Wiring Installation Details
1404289	Simulated Carrier Deck Lighting and Plan and Wiring Diagram
1404290	Simulated Carrier Deck Lighting Details

b) FAA Advisory Circulars:

FAA AC 150/5340-4	Runway Centerline and Touchdown Zone Lighting Systems. (For installation methods only)

c) Guide Specifications:

NFGS-16560	Airfield Lighting

5.1.9 Compliance with International Standards. There are no ASCC or NATO Standards covering simulated carrier deck lighting.

5.2 Wheels-Up Lighting (Cat. Code 136-45)

5.2.1 Description. Wheels-up lights are a bar of white lights installed under the approach which are aimed upward and toward the threshold. They are intended to illuminate the underside of landing aircraft to permit observers to determine that the landing gear is fully lowered. The system also includes a portable wheels-watch shelter which protects the observer from the weather and a wheels-watch control panel.

5.2.2 Configuration

5.2.2.1 Wheels-Watch Light Bar. As illustrated in Facility Plate Number 136-45 Sheet 1 of 11, the wheels-watch light bar consists of a row of lights installed 980 ± 5 ft (298.7 ± 1.5 m) from the threshold and on a line perpendicular to the extended runway centerline. As illustrated in Facility Plate Number 136-45 Sheet 8 of 11, the light bar consists of 20 lights spaced 5 feet (1.5 m) apart with the innermost light 105 feet (32 m) from the extended runway centerline. The light bar shall be on the same side of the runway centerline as the air traffic control tower. This line of lights is to be horizontal ± 2 inches (50.8 mm). The height of the lights with the shortest support shall be 26 inches (660.4 mm) maximum above the ground or paved surface. The horizontal aiming of the three innermost lights is toward the runway and 25 degrees toward the runway centerline from a line through the light parallel to the runway centerline and 30 degrees for the remaining lights. Vertical aiming is 30 degrees above the horizontal. The tolerance for the aiming, is to be ±1 degree. The wheels-watch handhole and control panel shall be located 5 feet (1.5 m) outboard of the outermost light.

5.2.2.2 Wheels-Watch Equipment Pad. The wheels-watch equipment pad shall be located as approved by NAVAIR. The pad should be located as close as practical to the wheels-watch handhole and control panel. Refer to Facility Plate Number 136-45 Sheet 2 of 11 for pad details.

5.2.2.3 Wheels-Watch Control Panel. The wheels-watch control panel is located approximately 10 ft (3 m) downwind of the wheels-watch light bar and approximately 205 feet (62.48 m) from the runway centerline. As illustrated in Facility Plate Number 136-45 Sheet 11 of 11, the panel contains the on/off and brightness controls and also provides an external connection for the waveoff light control switch.

5.2.2.4 Wheels-Watch Shelter. The portable wheels-watch shelter is Government-furnished. The system design includes the preparation of a parking area for the shelter adjacent to the wheels-watch control panel together with suitable access to the site.

5.2.3 Power Requirements. Wheels-up lights are connected to 120 Vac multiple circuits requiring somewhat in excess of 10 kW. A 15 kVA pad mount transformer (weatherproof) is recommended.

5.2.4 Control Requirements. Wheels-up lights require on/off control and continuous intensity control from 10 to 100 percent of intensity at the rated voltage. This control is required only at the wheels-watch control panel. Refer to Facility Plate Number 136-45 Sheet 9 of 11 for details.

5.2.5 Equipment Requirements

5.2.5.1 Fixtures. Fixtures shall be as shown on Facility Plate Number 136-45 Sheet 10 of 11.

5.2.5.2 Supports. Fixture supports shall be as illustrated in Facility Plate Number 136-45 Sheet 10 of 11.

5.2.6 Additional Design Guidance.

a) Guide Specifications:

NFGS-16560 Airfield Lighting

5.2.7 Compliance with International Standards. There are no ASCC or NATO Standards pertaining to this system.

5.3 Waveoff Lights (Cat. Code 136-45)

5.3.1 Description. The runway waveoff light system consists of sets of simultaneously flashing red lights installed adjacent to the runway which are aimed toward the threshold. They are intended to inform the pilot that an emergency waveoff or missed approach procedure is necessary. The runway waveoff shall be activated from either the control tower, airfield lighting vault, or the wheels-watch station.

5.3.2 Configuration. For new installations or replacement of existing systems the waveoff lights shall be in accordance with specification MIL-L-29575 (AS) and shall consist of waveoff lights, power converter units, and power and control equipment.

5.3.2.1 Waveoff Lights. As illustrated in Facility Plate Number 136-45 Sheet 1 of 11, the waveoff system consists of six optical assembly units (flashheads) each along the runway edge in the touchdown area. The flashheads are in pairs outbound of the runway edge. Each pair of flashheads shall be on a line at right angles ± 1 degree to the runway centerline and located in a

Figure 23
Figure Not Used

straight line parallel to the runway centerline 10 feet (3.1 m) outside the runway edges. The three pairs of flashheads shall be 900, 1700, and 2500 feet from the runway threshold. A pair of flashheads may be moved the least practical distance up to 100 feet (30.5m) to provide clearance for runway and taxiway intersections, facilities such as arresting gear and OLS, and major construction problems.

5.3.2.2 Waveoff Power Converter Units. A power converter unit (PCU) is required to provide power for each flashhead. As illustrated in Facility Plate Number 136-45 Sheet 1 of 11, the PCUs are located in straight lines parallel to the runway centerline in line with the related flashheads perpendicular to the runway centerline. The PCUs are located 50 feet (15.2m) from the runway edge and may be moved per NAVAIR approval.

5.3.2.3 Waveoff Equipment Pad. The waveoff equipment pad shall be located as approved by NAVAIR. The pad should be located as close as practical to the PCU as shown in Facility Plate 136-45 Sheet 1 of 11. Refer to Facility Plate Number 136-45 Sheet 2 of 11 for pad details.

5.3.3 Power Requirements. Power for the waveoff power converter unit (PCU) shall be from a 480 volt source. A single 10 KVA minimum 2400/480V pad mount (weatherproof) transformer may supply the power for the waveoff lights via the PCU. Refer to Facility Plate Number 136-45 Sheet 3 of 11 for typical wiring details.

5.3.4 Control Requirements. The waveoff lights shall be controlled manually using momentary-contact type switches. The switches shall be located only at the control tower, airfield lighting vault, and the wheels-watch station. Refer to Facility Plate Number 136-45 Sheets 3 and 4 of 11 for control wiring diagrams.

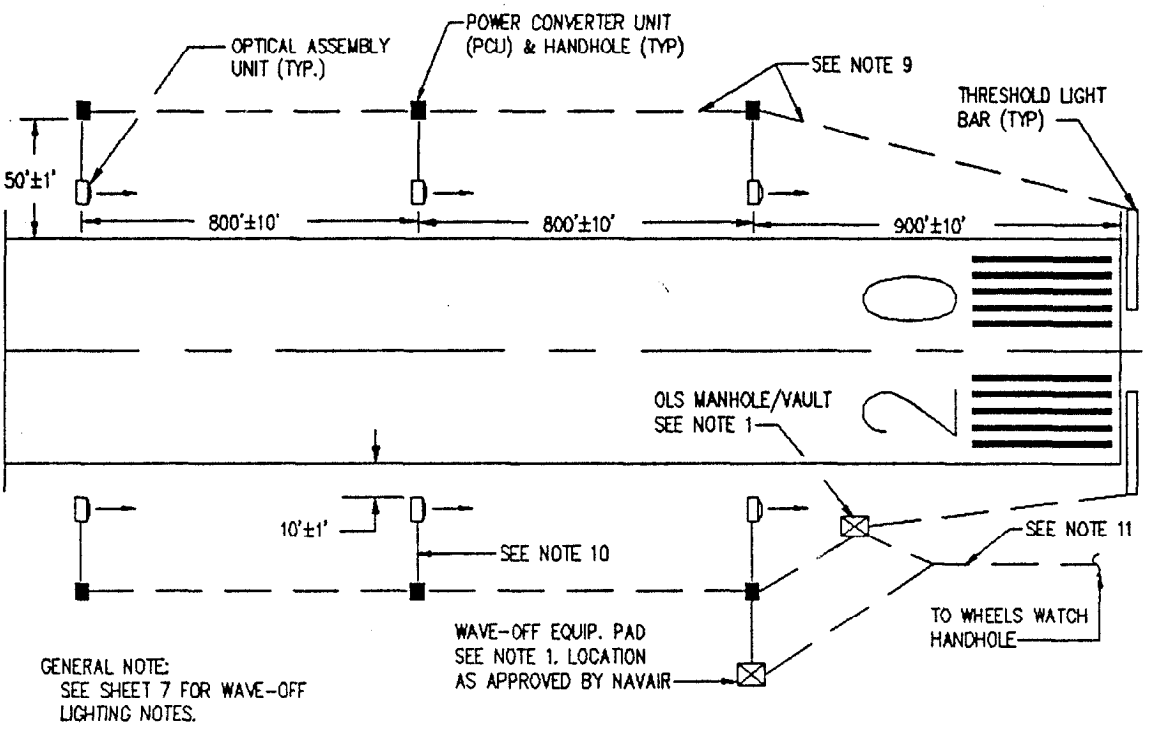
5.3.5 Equipment Requirements

5.3.5.1 Optical Assembly Units (Flashheads). Flashheads shall meet MIL-L-29575. Refer to Facility Plate Number 136-45 Sheets 5 of 11 for flashhead details.

5.3.5.2 Power Converter Units (PCU). Power Converter Units shall meet MIL-L-29575 (AS). Refer to Facility Plate Number 136-45 Sheet 6 of 11 for PCU details.

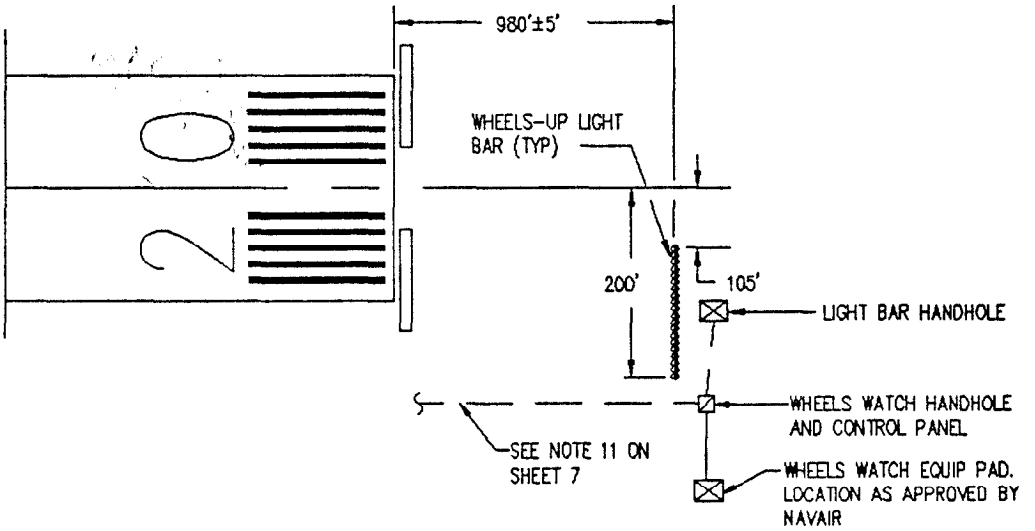
5.3.6 Compliance with International Military Standards. Neither NATO nor ASCC standards cover runway waveoff lights.

5.4 Related Facilities. Optical Landing Systems (OLS) are often installed in conjunction with the facilities described in this section. Design guidance for these facilities can be found in NAVAIR 51-50AAA-2, "General Requirements for Shorebased Airfield Marking and Lighting".



LOCATION PLAN – WAVE-OFF LIGHTING

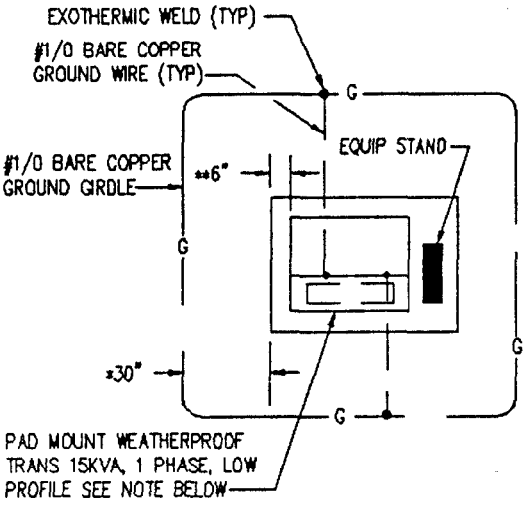
NO SCALE



LOCATION PLAN – WHEELS-UP LIGHTING

NO SCALE

TITLE	DATE	FACILITY PLATE NO.	SHEET
LOCATION PLANS WAVE-OFF & WHEELS UP LIGHTING SYSTEMS	OCT 90	136-45	1 of 11

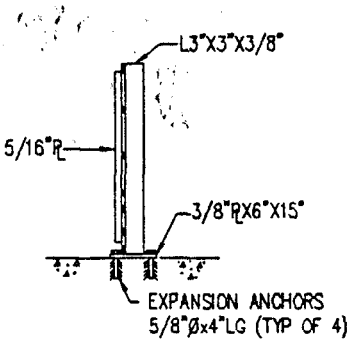


* MINIMUM CLEARANCE ALL AROUND
** MINIMUM CLEARANCE FROM EQUIPMENT TO EDGE OF PAD

NOTE: TRANSFORMER SHALL BE RATED AS FOLLOWS:
WAVE-OFF SYS - 2400V PRI TO 480V SEC
WHEELS UP SYS - 2400V PRI TO 120/240V SEC

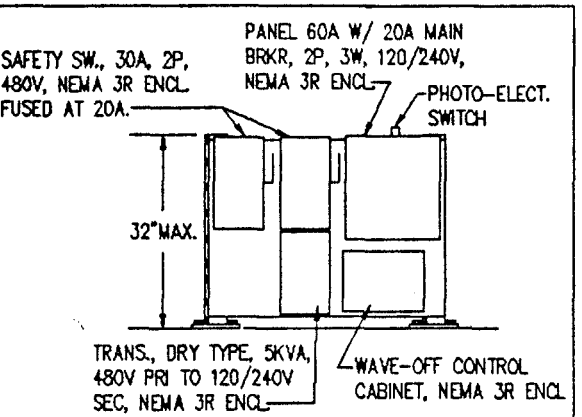
EQUIPMENT PAD
WAVE-OFF & WHEELS UP SYS

NO SCALE



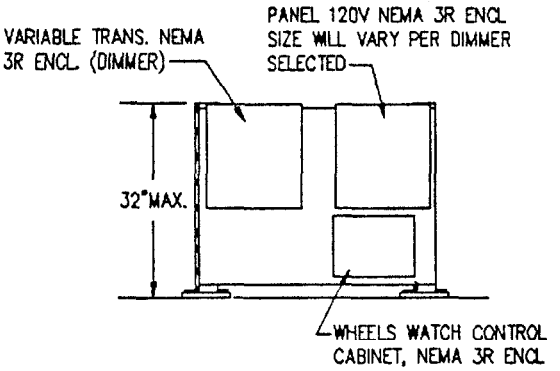
STAND DETAILS
SIDE VIEW

NO SCALE



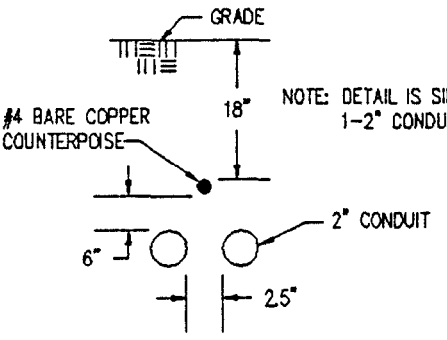
EQUIPMENT STAND
WAVE-OFF SYSTEM

NO SCALE



EQUIPMENT STAND
WHEELS UP SYSTEM

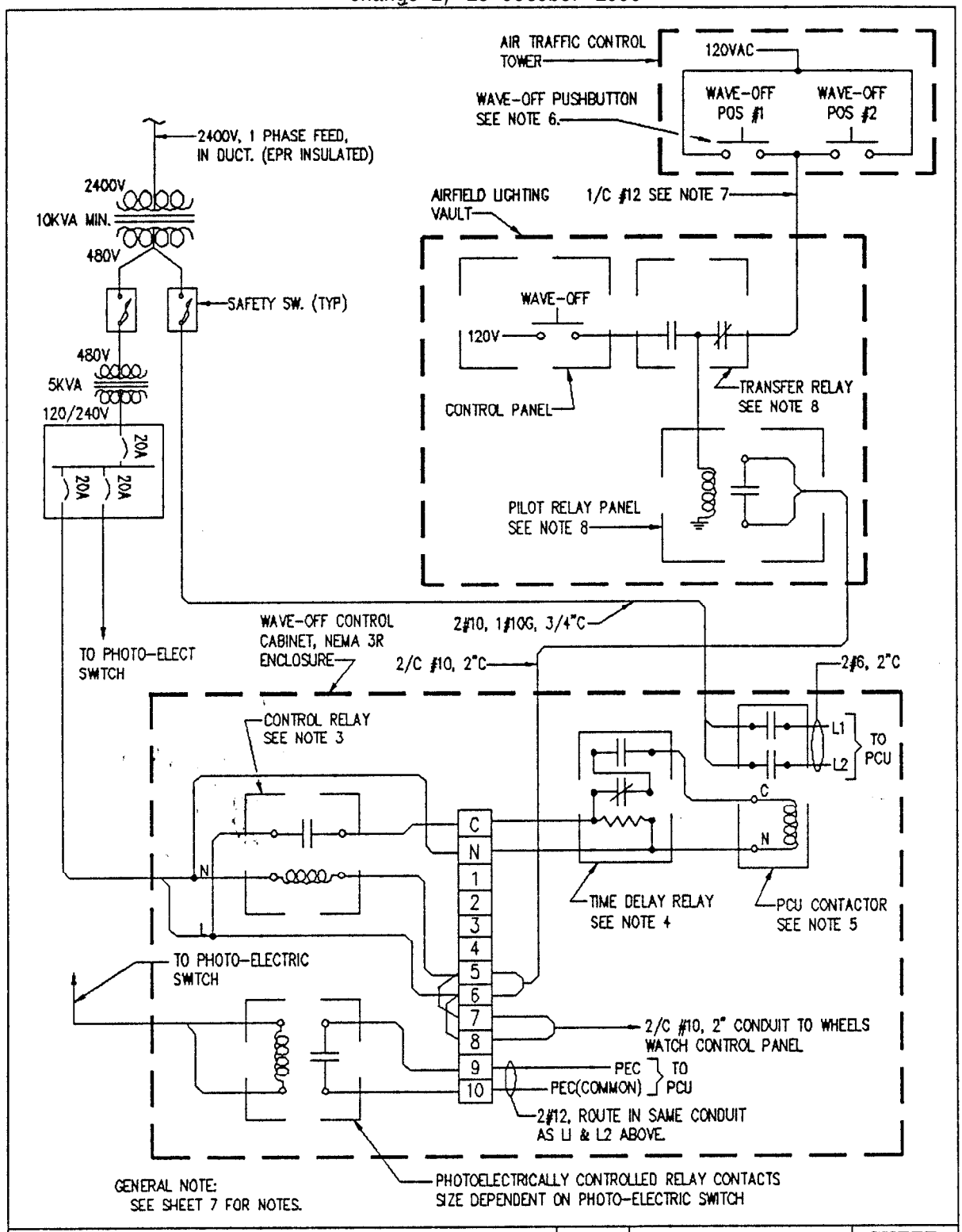
NO SCALE



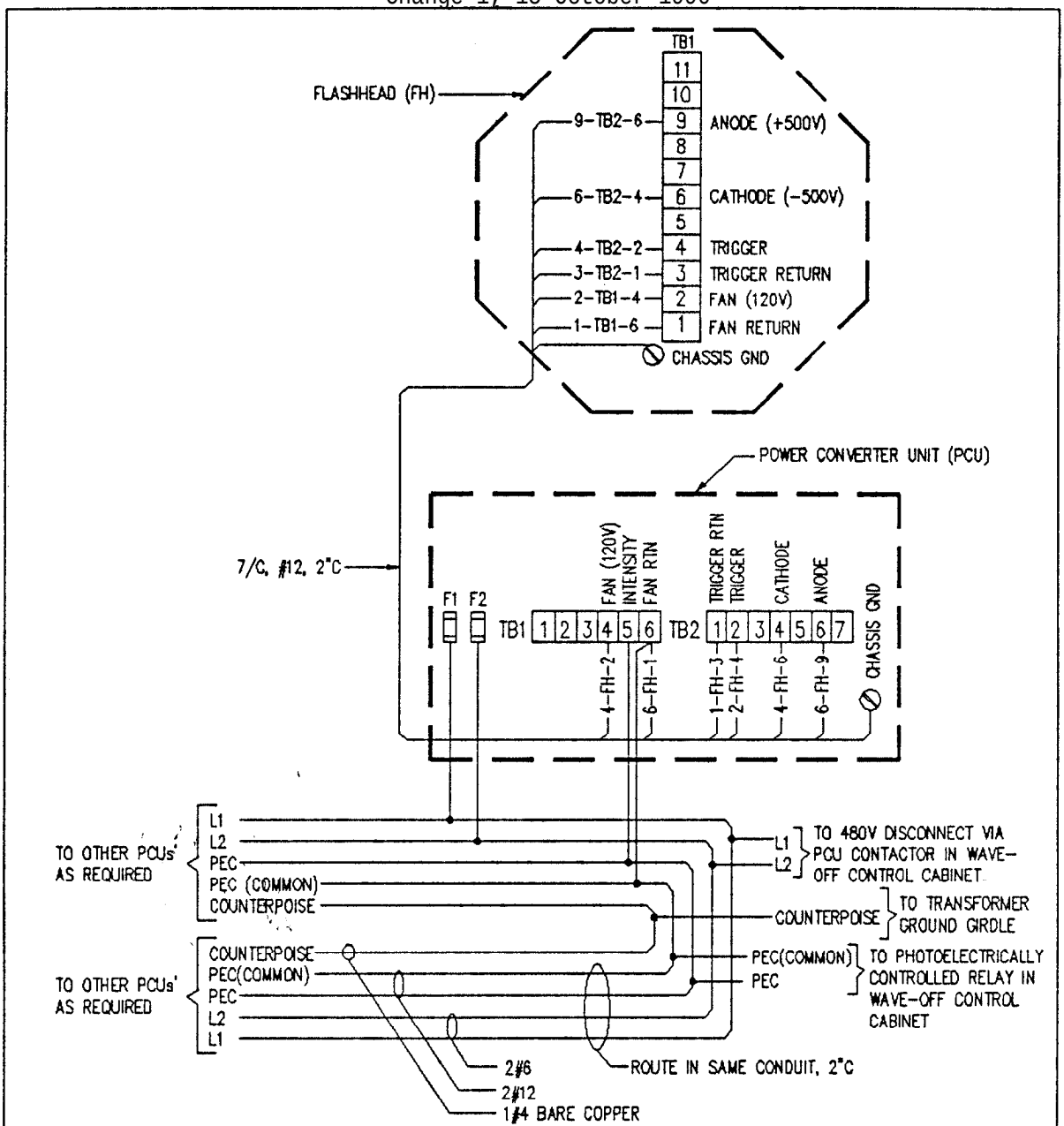
DUCT DETAIL

NO SCALE

TITLE	DATE	FACILITY PLATE NO.	SHEET
EQUIPMENT PAD AND DUCT DETAILS	OCT 90	136-45	2 of 11

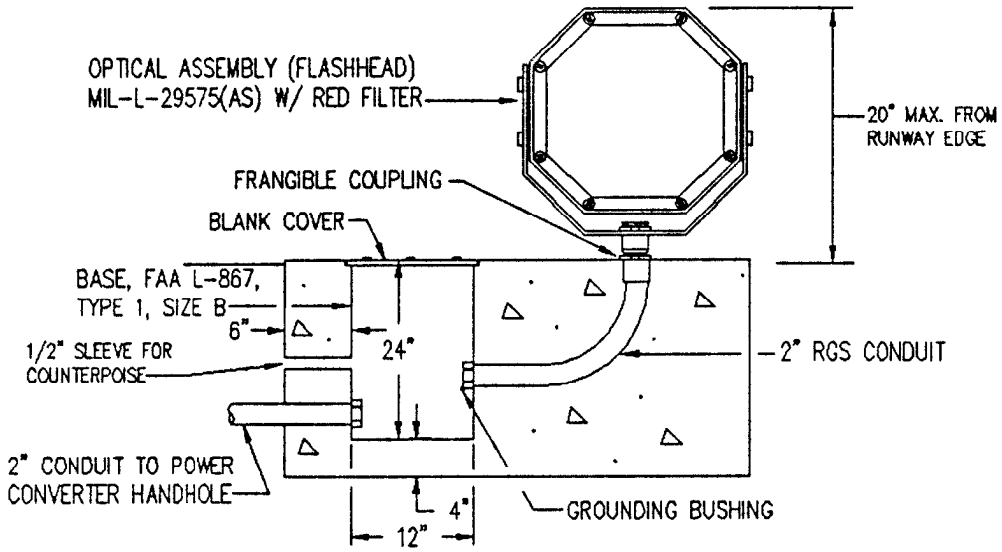


TITLE	DATE	FACILITY PLATE NO.	SHEET
WAVE-OFF WIRING DIAGRAM	OCT 90	136-45	3 of 11



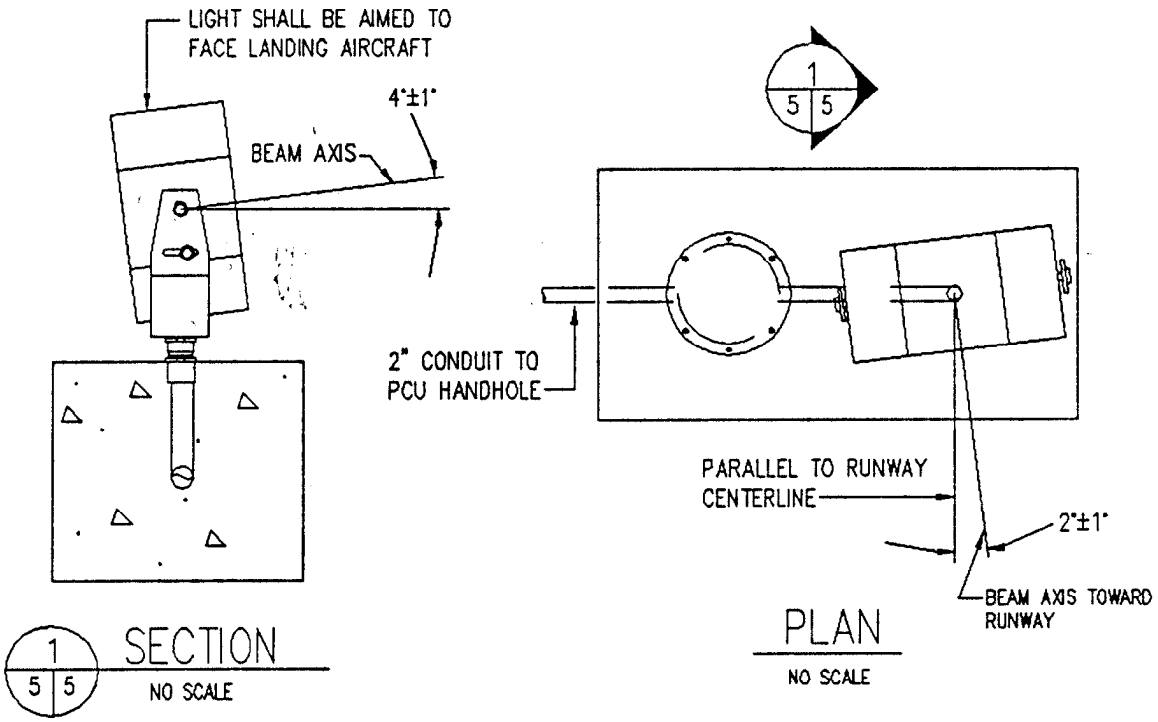
GENERAL NOTE:
WIRING DIAGRAM IS TYPICAL FOR ALL PCUs AND FLASHHEADs.

TITLE	DATE	FACILITY PLATE NO.	SHEET
FLASHHEAD AND PCU WIRING DIAGRAM	OCT 90	136-45	4 of 11

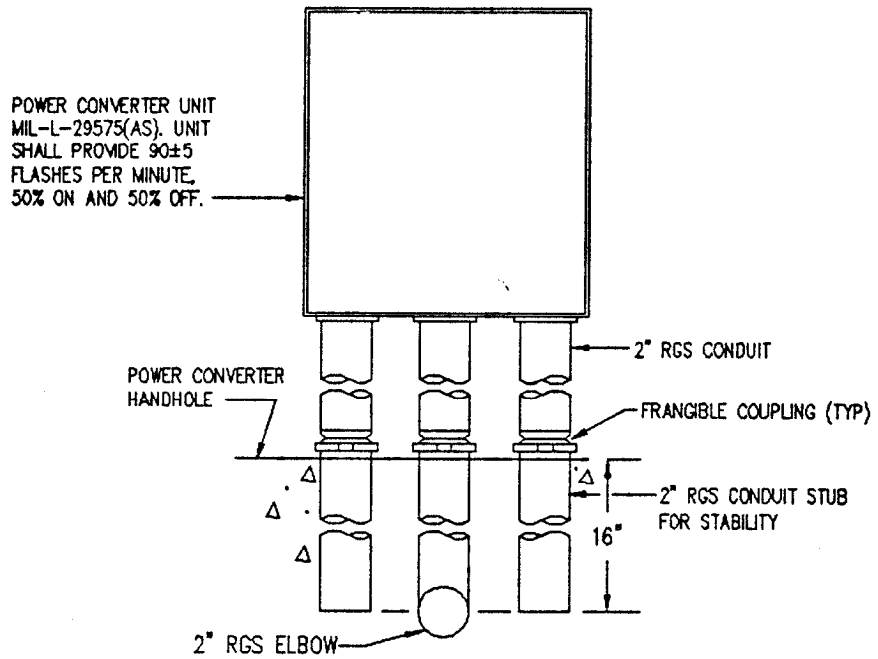


WAVE-OFF LIGHT FIXTURE

NO SCALE

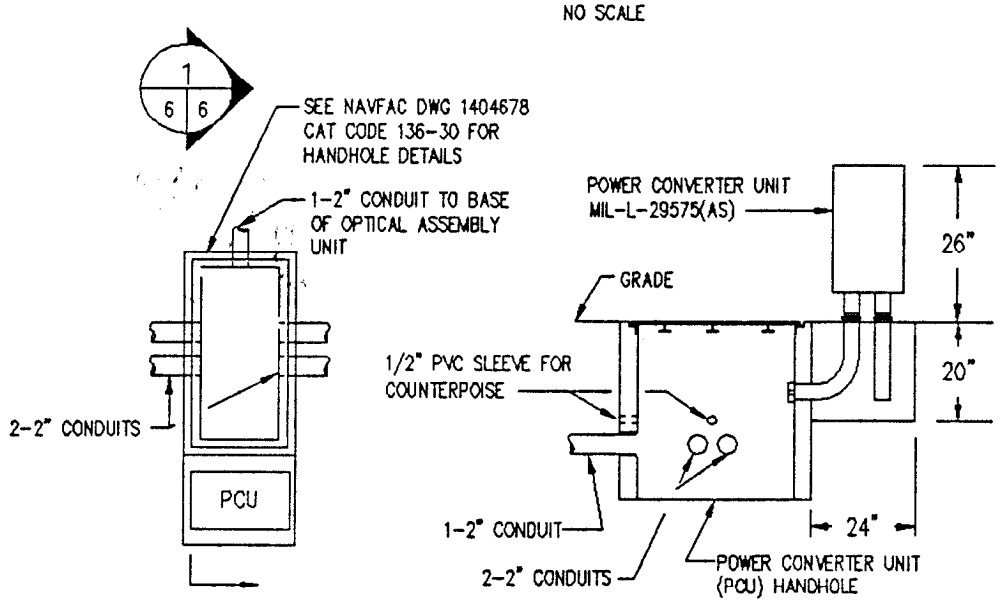


TITLE	DATE	FACILITY PLATE NO.	SHEET
DETAILS – OPTICAL ASSEMBLY UNIT	OCT 90	136-45	5 of 11



POWER CONVERTER UNIT

NO SCALE



PLAN

NO SCALE

1
6 6 SECTION

NO SCALE

TITLE	DATE	FACILITY PLATE NO.	SHEET
DETAILS – POWER CONVERTER UNIT	OCT 90	136-45	6 of 11

NOTES

1. IF AN OPTICAL LANDING SYSTEM (OLS) MANHOLE/VAULT WITH 480VAC POWER IS NOT AVAILABLE, PROVIDE AN EQUIPMENT PAD WITH PAD MOUNT TRANSFORMER AS DETAILED ON SHEET 2. IN ADDITION MODIFY THE CONTROLS AS SHOWN ON SHEET 3. THE CONTROLS MAY BE LOCATED IN THE OLS MANHOLE/VAULT IF ONE EXISTS.

2. ALL EQUIPMENT IN THE UNDERGROUND MANHOLE/VAULT SHALL EITHER BE SUBMERSIBLE OR INSTALLED WITHIN A SUBMERSIBLE ENCLOSURE, NEMA 6P ENCL.

3. CONTROL RELAY SHALL BE GENERAL PURPOSE, HERMETICALLY SEALED, 4PDT, 3 AMP CONTACTS WITH 120VAC, 60Hz COIL.

4. TIME DELAY RELAY SHALL HAVE 10 AMP, 120VAC CONTACTS WITH 120VAC 60Hz COIL RELAY SHALL HAVE ONE NORMALLY OPEN (N.O.) INSTANTANEOUS CONTACTS AND ONE NORMALLY CLOSED (N.C.) TIME DELAY OPENING CONTACT ADJUSTABLE FROM 5 TO 60 SECOND DELAY ON ENERGIZING BUT INITIALLY SET FOR 15 SECONDS DELAY.

5. CONTACTOR SHALL HAVE TWO N.O., 30 AMP, 480VAC CONTACTS WITH 120VAC, 60Hz COIL.

6. WAVE-OFF PUSHBUTTONS SHALL BE N.O. MOMENTARY CONTACTS. LOCATE PUSHBUTTONS WITHIN CONTROL TOWER AS DIRECTED BY THE AIR TRAFFIC CONTROL OFFICER.

7. IF POSSIBLE USE SPARE CONDUCTORS IN THE CONTROL TOWER THAT RUNS BETWEEN THE AIRFIELD LIGHTING VAULT AND THE CONTROL PANEL WITHIN THE CONTROL TOWER.

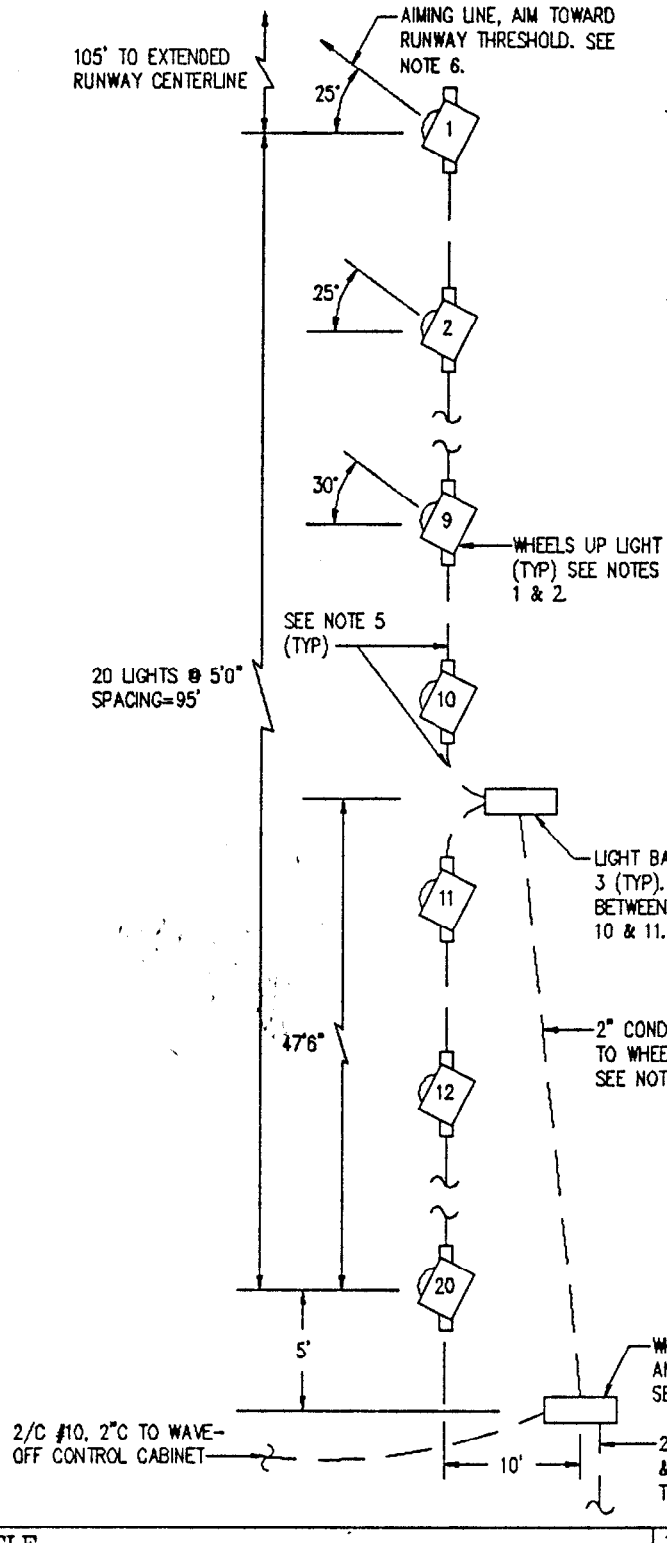
8. IF AVAILABLE USE SPARE PILOT AND TRANSFER RELAYS WITHIN THE AIRFIELD LIGHTING VAULT.

9. PROVIDE 2-2" CONDUITS (1-SPARE) BETWEEN POWER CONVERTER UNITS (PCU). ALSO PROVIDE 2-2" CONDUITS (1-SPARE) BETWEEN PCU AND THRESHOLD.

10. PROVIDE 1-2" CONDUIT BETWEEN PCUs AND OPTICAL ASSEMBLY UNITS.

11. IF THE WAVE-OFF CONTROLS ARE LOCATED IN THE OLS MANHOLE/ VAULT ROUTE 1-2" CONDUIT FROM MANHOLE/VAULT TO WHEELS WATCH HANDHOLE OTHERWISE ROUTE 1-2" CONDUIT FROM WAVE-OFF EQUIPMENT PAD TO WHEELS WATCH HANDHOLE.

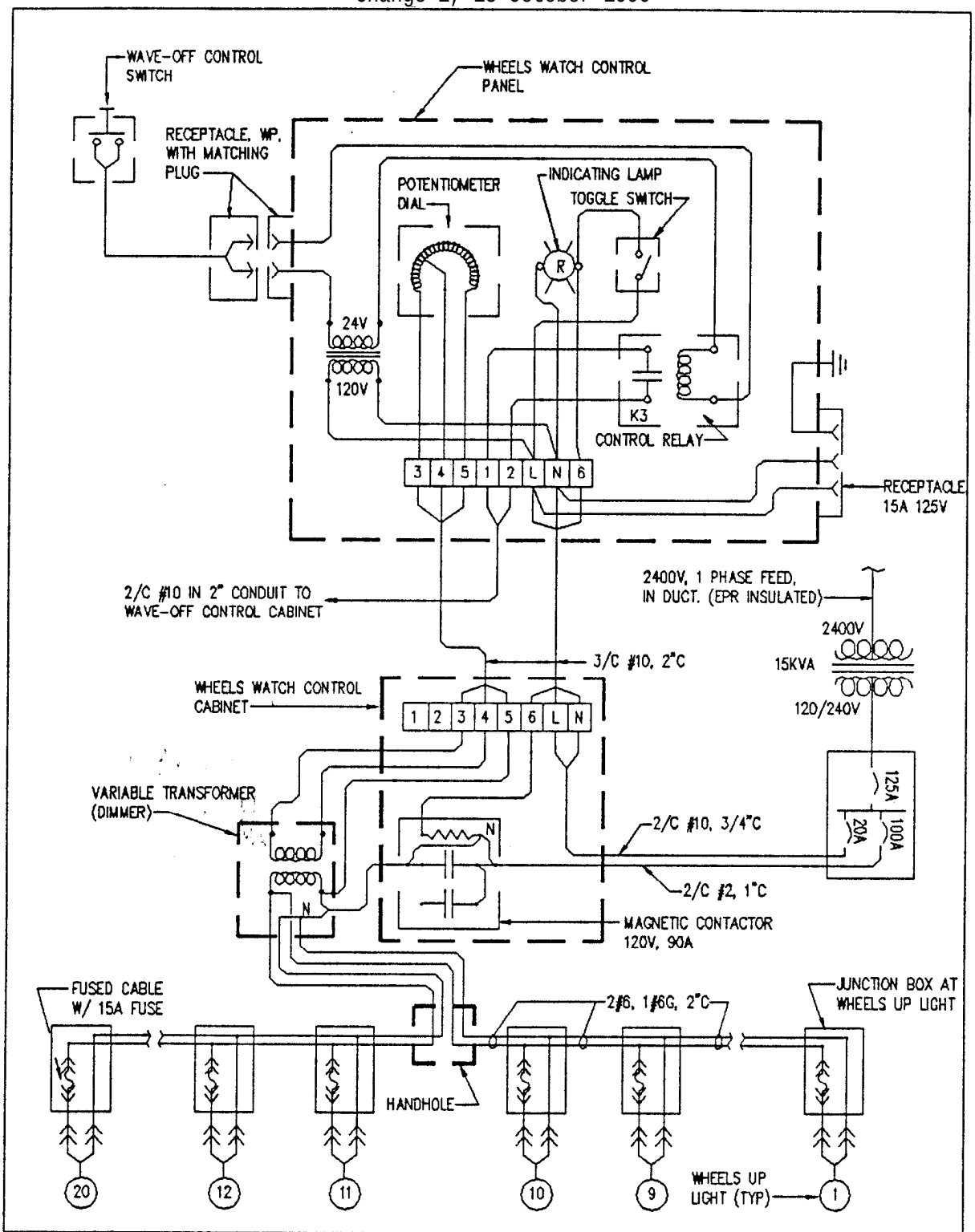
TITLE	DATE	FACILITY PLATE NO.	SHEET
NOTES – WAVE OFF LIGHTING SYSTEM	OCT 90	136–45	7 of 11



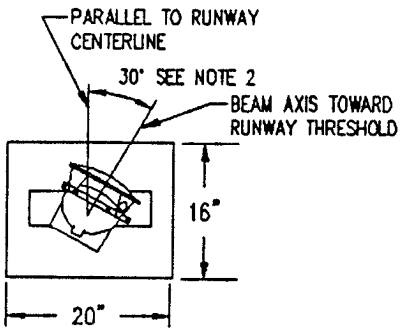
NOTES

1. WHEELS UP LIGHT BAR SHALL BE LOCATED ON SAME SIDE OF RUNWAY AS THE CONTROL TOWER.
2. RELOCATION OR REAIMING OF LIGHT BAR REQUIRES APPROVAL OF NAVFACENGCOM.
3. SEE NAVFAC DRAWING NUMBER 1404678 CATEGORY CODE 136-30 FOR HANDHOLE DETAILS.
4. CONDUCTOR SIZE BETWEEN LIGHT BAR HANDHOLE AND WHEELS UP EQUIPMENT PAD SHALL BE DETERMINED ONCE LOCATION OF EQUIPMENT PAD IS APPROVED BY NAVAIR. THE TOTAL VOLTAGE DROP FOR THE WHEELS UP LIGHTING CIRCUIT SHALL BE MAINTAINED TO ±4% OR LESS.
5. CONDUCTOR SIZE BETWEEN LIGHT BAR HANDHOLE AND WHEELS UP LIGHTS SHALL BE 2#6, 1#6G IN 2" CONDUIT.
6. THE THREE (3) INNER MOST LIGHTS ARE AIMED TOWARD THE RUNWAY AT 25°.

TITLE	DATE	FACILITY PLATE NO.	SHEET
ENLARGED PLAN-WHEELS UP LIGHT BAR	OCT 90	136-45	8 of 11

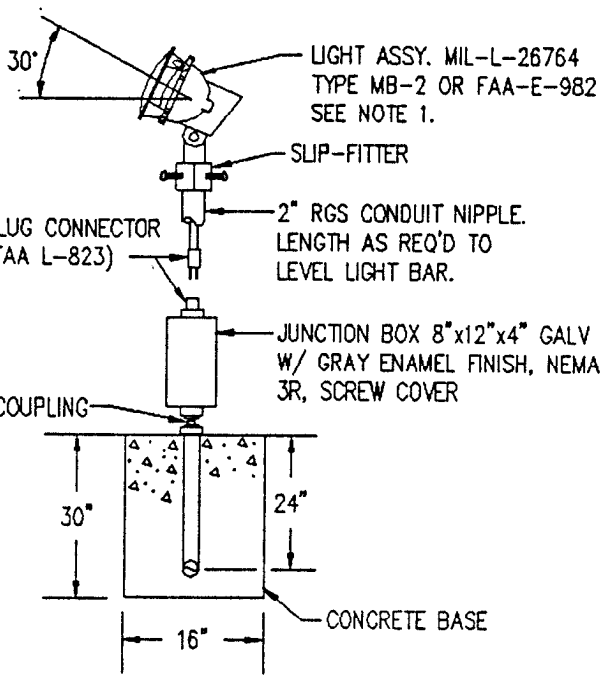


TITLE	DATE	FACILITY PLATE NO.	SHEET
WHEELS UP WIRING DIAGRAM	OCT 90	136-45	9 of 11



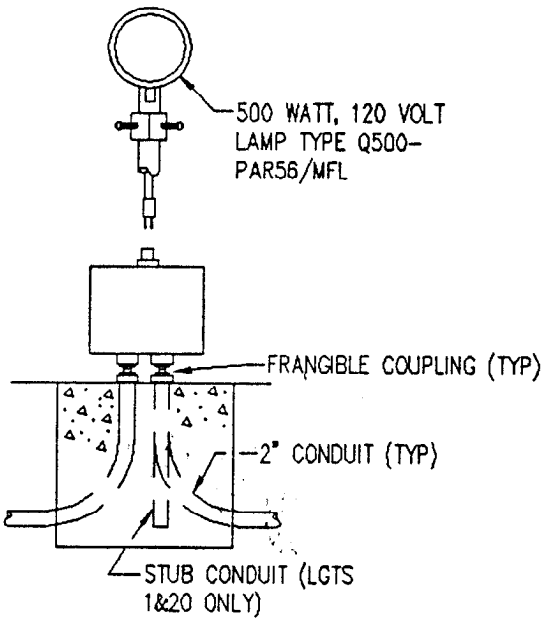
PLAN

NO SCALE



SIDE VIEW

NO SCALE



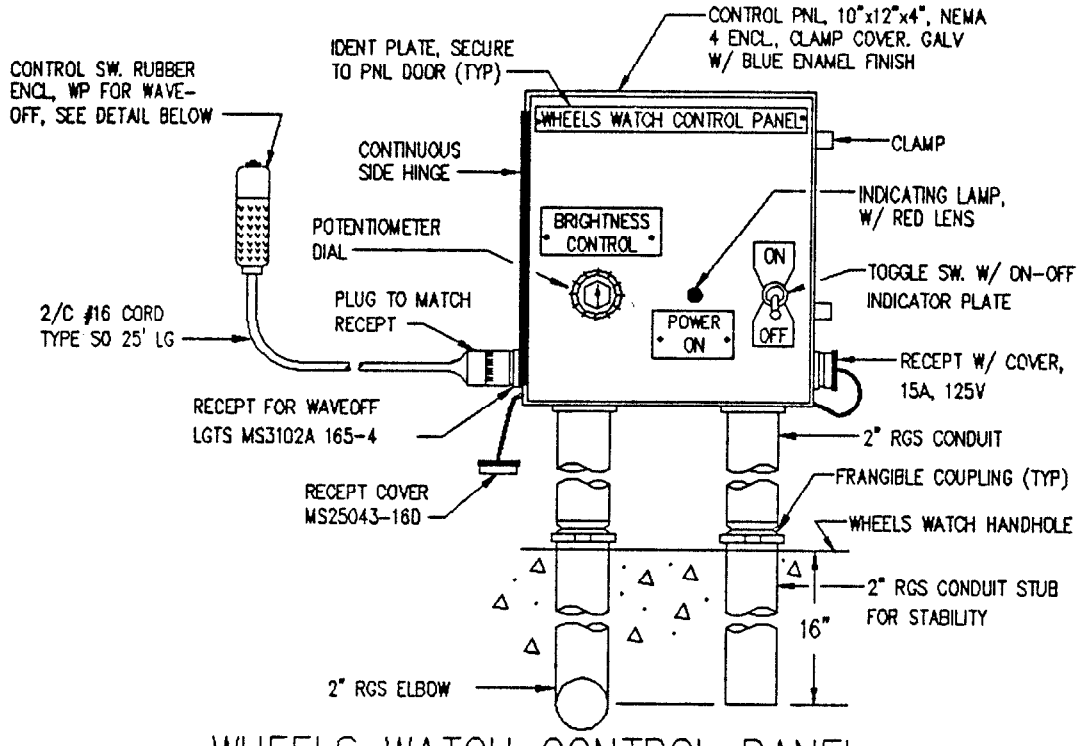
ELEVATION

NO SCALE

NOTE

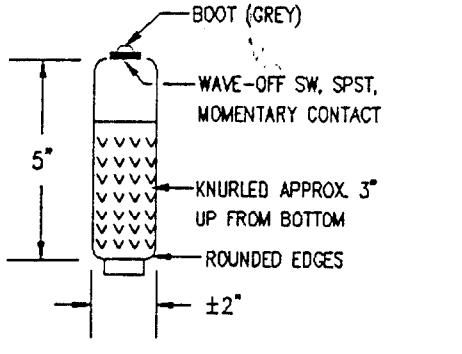
1. THE LAMP SHORTING DEVICE PROVIDED WITH THE FAA-E-982 FIXTURE IS NOT REQUIRED.
2. THE THREE (3) INNER MOST LIGHTS ARE AIMED TOWARD THE RUNWAY AT 25°.

TITLE	DATE	FACILITY PLATE NO.	SHEET
DETAILS - WHEELS UP LIGHT	OCT 90	136-45	10 of 11



WHEELS WATCH CONTROL PANEL

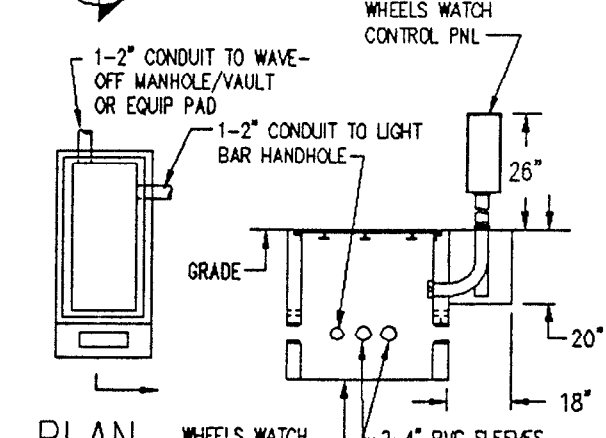
NO SCALE



WAVE-OFF CONTROL SW

NO SCALE

1
11 | 11



PLAN

1
11 | 11

SECTION

NO SCALE

TITLE	DATE	FACILITY PLATE NO.	SHEET
DETAILS-WHEELS WATCH CONTROL PNL	OCT 90	136-45	11 of 11

Section 6: HELIPAD LIGHTING SYSTEMS

6.1 Perimeter Lighting (Cat. Code 136-65)

6.1.1 Description. Perimeter lights are a series of aviation lights installed on or near the perimeter of the helipad that provide location and size information to the helicopter pilot.

6.1.2 Configuration

6.1.2.1 Helipad. As illustrated in Facility Plate Number 136-65 Sheet 1 of 6, aviation yellow, omnidirectional lights are placed at each corner of the helipad. Three additional yellow lights are equally spaced along each side in line with the corner lights. The lines of lights must be equidistant from the axes of the helipad and are usually on the perimeter of the pad. The lights may be placed not more than 7.5 feet (2.3 m) from the marked edge of the pad. Frangible mounted elevated light fixtures shall be used, except semiflush fixtures may be used in areas subject to vehicular traffic. All perimeter lights installed in paved shoulders shall be mounted on airfield light bases. Elevated light fixtures shall not exceed 14 inches (356 mm) above ground. If snow accumulations of 12 inches (305 mm) or more are frequent, mounting height may be increased to not more than 24 inches (610 mm) above grade.

6.1.2.2 Hospital Helipad. As illustrated in Facility Plate Number 136-65 Sheet 2 of 6 and in addition to the requirements of paragraph 6.1.2.1, the center light of each line of perimeter lights shall be aviation red, omnidirectional with an additional red light located 25 feet (7.6 m) outboard and in-line with the center light.

6.1.3 Adjustments. The offset distance of the line of lights should be uniform for all sides of the helipad and should be selected to minimize installation problems. The location of individual lights may be adjusted not more than 12 inches (305 mm) longitudinally along, and not more than 6 inches (152 mm) laterally from, the line of lights to avoid installation problems.

6.1.4 Power Requirements. Perimeter lights are connected to 6.6 A series lighting circuits independent of other helipad lighting systems. The lighting system may be supplied from a 120 volt, 60 hertz source where economically feasible. Emergency power is required for hospital helipads.

6.1.5 Controls Requirements. Perimeter lights require on/off and brightness controls. Where series lighting circuits are used, provide

3-step brightness control. Brightness controls may be paired with those of other lighting systems for the same helipad.

6.1.6 Equipment Requirements

6.1.6.1 Elevated Fixtures. Elevated fixtures shall be FAA AC 150/5345-46, Type L-861, with yellow or red filters.

6.1.6.2 Semiflush Fixtures. Semiflush fixtures shall be FAA AC 150/5345-46, Type L-852E, with yellow or red filters.

6.1.6.3 Lamps. Lamps for helipad lighting equipment shall be as recommended by the manufacturer to meet the requirements of FAA AC 150/5345-46. Various manufacturers may meet the requirements using different lamps. In the interest of energy conservation, the use of lower wattage lamps is preferred.

6.1.7 Additional Design Guidance. There is little additional information available or required which is directly applicable to landing direction light systems. For installation methods the following publications may be useful:

a) FAA Advisory Circulars:

FAA AC 150/5340-19 Taxiway Centerline Lighting System
FAA AC 150/5340-24 Runway and Taxiway Edge Lighting System

b) Guide Specifications:

NFGS 16560 Guide Specification for Airfield Lighting

6.1.8 Compliance with International Military Standards

a) ASCC. These standards meet the requirements of ASCC Air Standard 65/16, Helipad Lighting (VMC), for VFR helipad lighting.

b) NATO. These standards meet the requirements of NATO STANAG 3652, Helipad Lighting (VMC), for VFR helipad lighting.

6.2 Landing Direction Lights (Cat. Code 136-65)

6.2.1 Description. Landing direction lights, where provided, consist of aviation yellow omnidirectional lights located in a straight line along one or more of the extended centerlines of the

helipad, perpendicular to the perimeter lights. These lights are installed to augment perimeter lights where preferential landing directions have been established.

6.2.2 Configuration. As illustrated in Facility Plate Number 136-65 Sheet 3 of 6, a landing direction light system consists of six omnidirectional yellow lights spaced 15 feet (4.6 m) on centers with the inner most light 25 feet (7.6 m) from the centerline of the line of perimeter lights and continuing along the axis of the helipad to a point 100 feet (30.5 m) from the perimeter light. The lights are to be in a horizontal plane. Frangible mounted elevated light fixtures shall be used, except semiflush fixtures may be used in areas subject to vehicular traffic. The lights, when not in paved areas, may be stake mounted.

6.2.3 Adjustments and Tolerances. The location of individual lights may be adjusted not more than 12 inches (305 mm) longitudinally along the line of lights to avoid installation problems. Where terrain makes a horizontal light plane impractical, the slope of the light plane may be adjusted from the horizontal to a slope of not more than plus 2 percent or minus 1 percent. Except for semiflush fixtures which shall not extend more than 1 inch (25 mm) above the mounting surface, the elevation of all fixtures shall be within 2 inches (51 mm) of the light plane at the light location. All lights shall be laterally within 4 inches (102 mm) of the centerline of the system.

6.2.4 Power Requirements. Landing direction lights are connected to a separate circuit so as to permit being turned off independently from the perimeter lights. Landing direction lights are connected to 6.6 A series lighting circuits and may be supplied from a 120 volt, 60 hertz source where economically feasible.

6.2.5 Control Requirements. Landing direction lights require on/off and brightness controls. Where series lighting circuits are used, provide 3-step brightness control. Controls shall be configured so that the landing direction lights cannot be turned on unless the perimeter lights are energized but may be turned off independently. Intensity controls may be in common with the intensity controls for the perimeter lights so as to permit connection to a common regulator.

6.2.6 Equipment Requirements

6.2.6.1 Elevated fixtures. Fixtures shall be FAA AC 150/5345-46, Type L-861, with yellow filters.

6.2.6.2 Semiflush fixtures. Semiflush fixtures shall be FAA AC 150/5345-46, Type L-852E, with yellow filters.

6.2.6.3 Lamps. Lamps for helipad lighting equipment shall be as recommended by the manufacturer to meet the requirements of FAA AC 150/5345-46. Various manufacturers may meet the requirement using different lamps. In the interest of energy conservation, the use of lower wattage lamps is preferred.

6.2.7 Additional Design Guidance. There is little additional information available or required which is directly applicable to landing direction light systems. For installation methods the following publications may be useful:

a) FAA Advisory Circulars:

FAA AC 150/5340-19 Taxiway Centerline Lighting System
FAA AC 150/5340-24 Runway and Taxiway Edge Lighting System

b) Guide Specifications:

NFGS 16560 Guide Specification for Airfield Lighting

6.2.8 Compliance with International Military Standards

a) ASCC. These standards meet the requirements of ASCC Air Standard 65/16, Helipad Lighting (VMC), for VFR helipad lighting.

b) NATO. These standards meet the requirements of NATO STANAG 3652, Helipad Lighting (VMC), for VFR helipad lighting.

6.3 Approach Direction Lights (Cat. Code 135-65)

6.3.1 Description. Approach direction lights, where provided, augment landing direction lights and consist of aviation white, omnidirectional lights located in a line extending out from the landing direction lights.

6.3.2 Configuration. As illustrated in Facility Plate Number 136-65 Sheet 4 of 6, an approach direction light system consists of five pairs of omnidirectional white lights spaced 50 feet (15.2 m) on centers with the centerline of the inner most pair 25 feet (7.6 m) from the Landing Direction light. Each pair of lights is perpendicular to the extended centerline of the pad and each light

within a pair is located 5 feet (1.5 m) from each side of the extended centerline of the helipad. Frangible mounted elevated light fixtures shall be used, except semiflush fixtures may be used in areas subject to vehicular traffic. The lights, when not in paved areas, may be stake mounted.

6.3.3 Adjustments and Tolerances. The centerline of the approach direction lights may be adjusted laterally not more than 4 inches (102 mm) from the extended centerline of the landing direction lights. The location of each pair of lights may be adjusted not more than 12 inches (305 mm) longitudinally along the centerline of lights to avoid installation problems. The plane of the approach direction lights shall be the same as that established for the landing direction light.

6.3.4 Power Requirements. Approach direction lights are connected to 6.6 A series lighting circuits and may be supplied from a 120 volt, 60 hertz source where economically feasible. They may be interconnected with the associated landing direction lights but must be capable of being turned off independently of other lighting systems.

6.3.5 Control Requirements. Approach direction lights require on/off and brightness controls. Where series lighting circuits are used, provide 3-step brightness control. Controls shall be configured so that the approach direction lights cannot be energized unless the landing direction lights are on. Intensity controls may be in common with other helipad lighting systems so as to permit connection to a common regulator.

6.3.6 Equipment Requirements

6.3.6.1 Elevated fixtures. Fixtures shall be FAA AC 150/5345-46, Type L-861, with white filters.

6.3.6.2 Semiflush fixtures. Semiflush fixtures shall be FAA AC 150/5345-46, Type L-852E, with white filters.

6.3.6.3 Lamps. Lamps for helipad lighting equipment shall be as recommended by the manufacturer to meet the requirements of FAA AC 150/5345-46. Various manufacturers may meet the requirement using different lamps. In the interest of energy conservation, the use of lower wattage lamps is preferred.

6.3.7 Additional Design Guidance. There is little additional information available or required which is directly applicable to

approach direction light systems. For installation methods the following publications may be useful:

a) FAA Advisory Circulars:

FAA AC 150/5340-19 Taxiway Centerline Lighting System
FAA AC 150/5340-24 Runway and Taxiway Edge Lighting System

b) Guide Specifications:

NFGS 16560 Guide Specification for Airfield Lighting

6.3.8 Compliance with International Military Standards

a) ASCC. These standards meet the requirements of ASCC Air Standard 65/16, Helipad Lighting (VMC), for VFR helipad lighting.

b) NATO. These standards meet the requirements of NATO STANAG 3652, Helipad Lighting (VMC), for VFR helipad lighting.

6.4 Helipad Floodlighting (Cat. Code 136-65)

6.4.1 Description. Helipad floodlights may be installed, where authorized, parallel to the normal approach to the pad and consist of two rows of floodlights on opposite sides of the pad. The floodlights shall be directed onto the pad below the horizontal and illuminated after helicopter touchdown.

6.4.2 Configuration. As illustrated in Facility Plate Number 136-65 Sheet 5 of 6 and within the following guidelines, the configuration is variable depending on the size of the helipad and the number and type of fixtures installed. Rows of floodlights should be opposite each other, equidistant from the centerline of the helipad and located no closer than 50 feet (15.2 m) from the marked edge of the pad. Floodlights shall be frangible mounted. The overall height of the floodlight above the helipad surface will be kept to a minimum that will permit the proper spread of light on the helipad, but in no case should this height exceed 4 feet (1.2 m) above grade of the helipad.

6.4.3 Fixtures. Floodlight fixtures shall be designed to direct the entire output of the fixture below the horizontal. The average horizontal luminance on the helipad surface shall be 3 footcandles (30 lux) with a uniformity ratio (average to minimum) of not more than 4 to 1. An obstruction light will be mounted on top of the floodlight

visible from above and at ground level from any direction around the floodlights.

6.4.4 Power Requirements. Floodlights and obstruction lights are normally connected to 120 Volt multiple circuits.

6.4.5 Control Requirements. Helipad floodlighting systems require on/off control and continuous brightness control from 10 percent to 100 percent of full brilliancy. Obstruction light shall be photo-electrically controlled.

6.4.6 Equipment Requirements

6.4.6.1 Floodlight Fixtures. Commercial floodlight fixtures shall conform to UL 1571, Incandescent Lighting Fixtures and be of a type which satisfies the requirements of paragraph 6.4.3 when installed.

6.4.6.2 Obstruction Light. Obstruction lights shall be FAA AC 150/5345-43, Type L-810, single light with red filter.

6.4.7 Compliance with International Military Standards

a) ASCC. These standards meet the requirements of ASCC Air Standard 65/16, Helipad Lighting (VMC), for VFR helipad lighting.

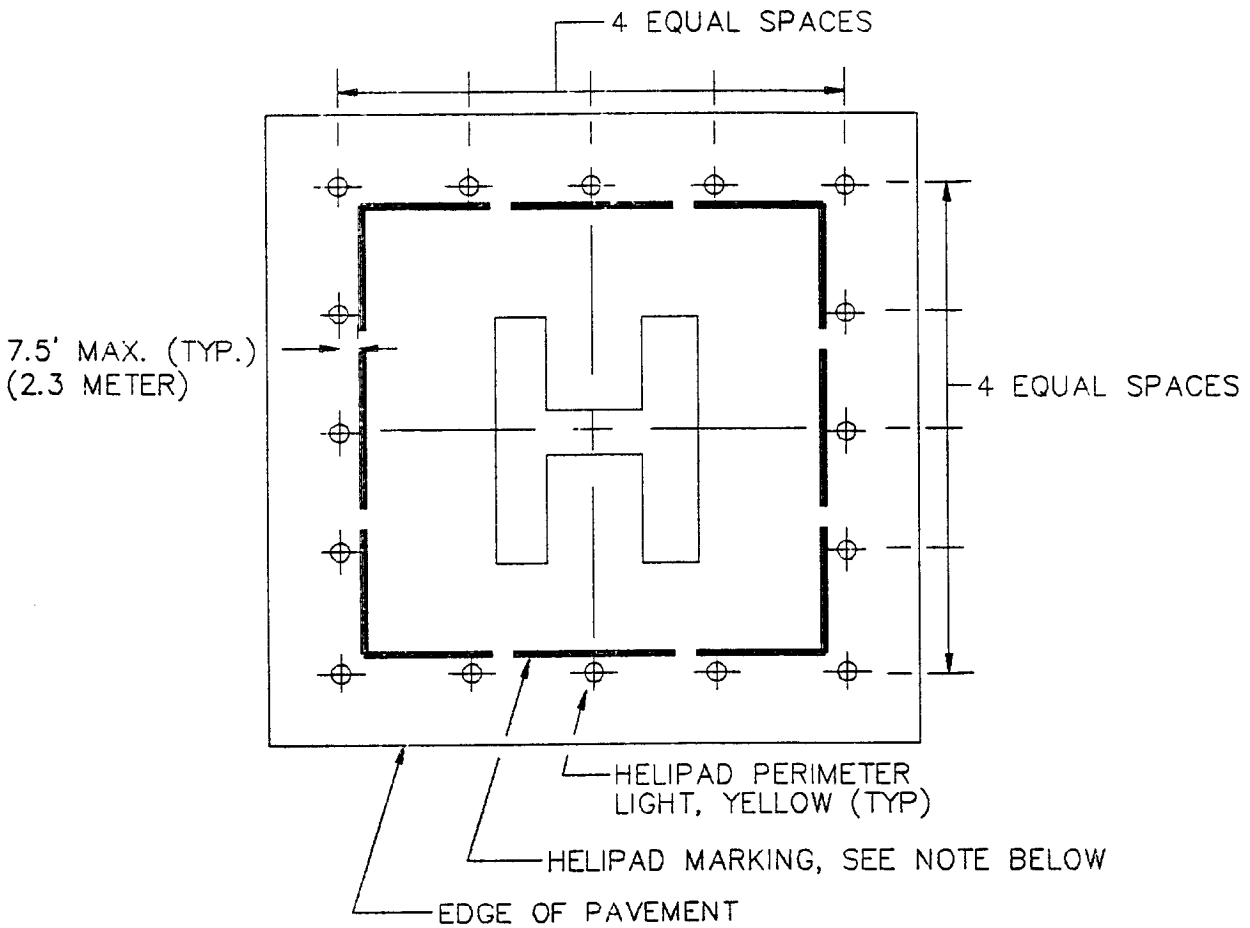
b) NATO. These standards meet the requirements of NATO STANAG 3652, Helipad Lighting (VMC), for VFR helipad lighting.

6.5 Visual Glide Slope Indicator (VGSI) (Cat. Code 136-65). A VGSI may be required at Army installations. Contact US Army Corps of Engineers, Transportation Systems Center, 12565 West Center Rd, Omaha, Nebraska, 68144-3869 for design guidance.

6.6 Rotating Beacon (Cat. Code 136-65). Refer to NAVAIR 51-50AAA-2 for design information. When used to identify a medical facility, the beacon shall have flashing lights, color coded white-green-red.

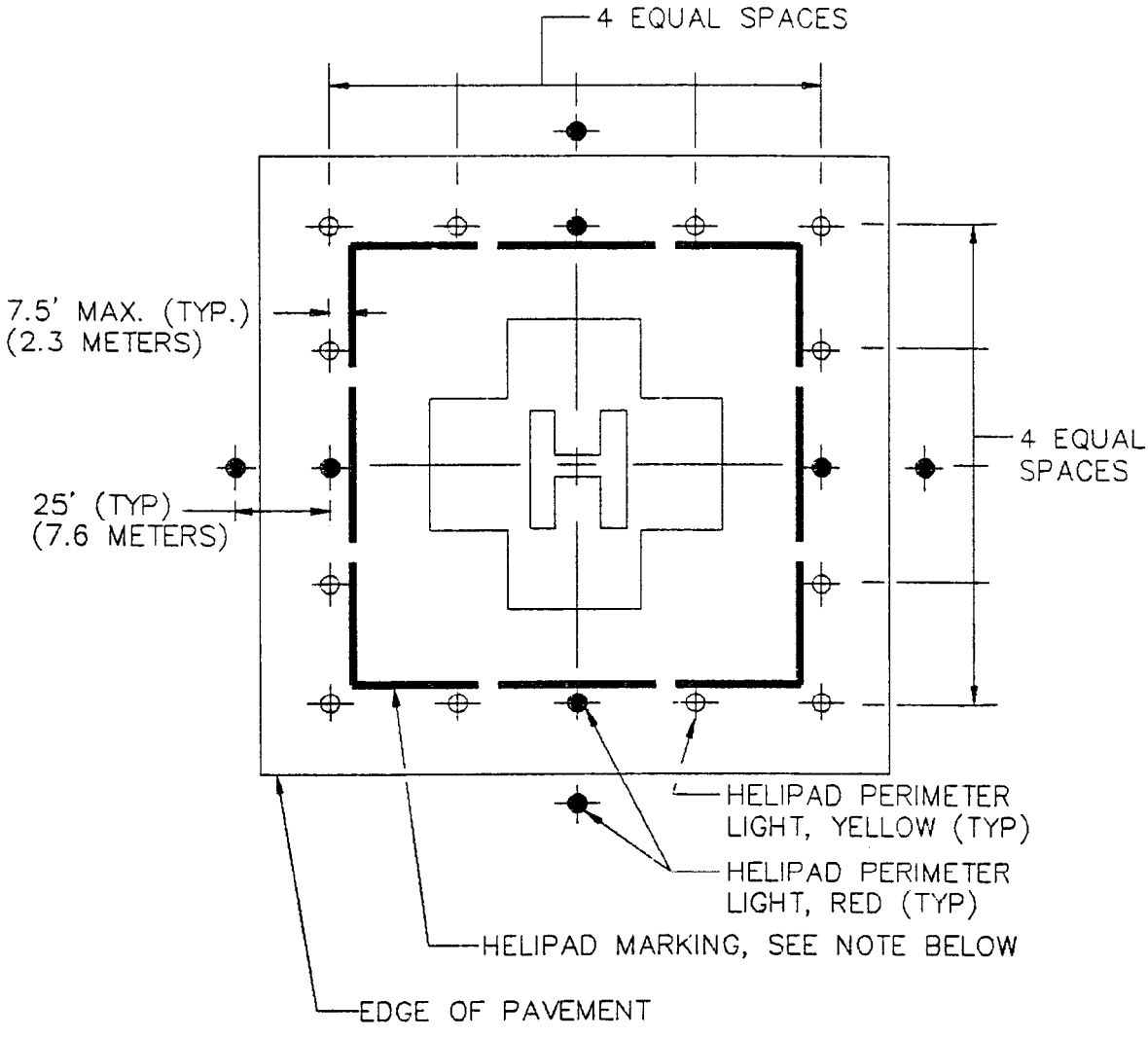
6.7 Wind Indicator (Cat. Code 136-65). Refer to NAVAIR 51-50AAA-2 for design information.

6.8 Radio Controller. A radio controller may be required at Army installations. Contact US Army Corps of Engineers, Transportation Systems Center, 12565 West Center Rd, Omaha, Nebraska, 68144-3869 for design guidance.



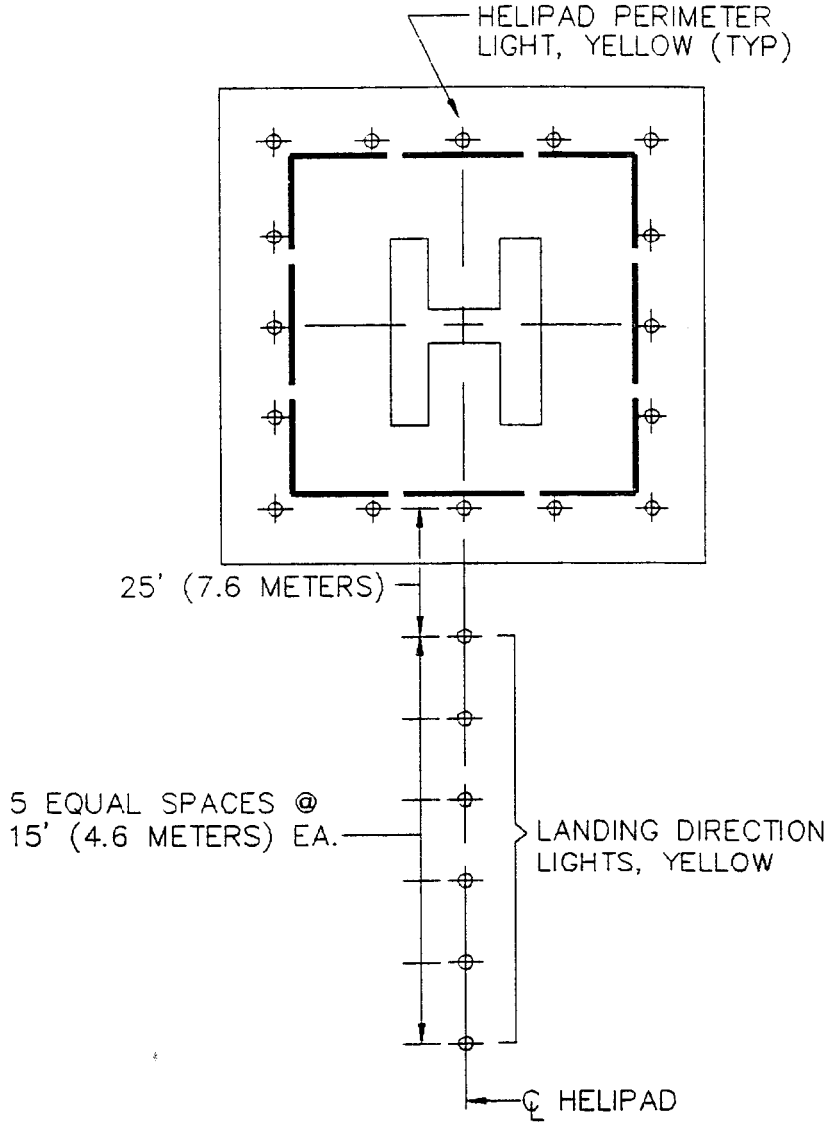
NOTE:
SEE NAVAIR 51-50AAA-2
FOR MARKING STANDARDS

TITLE	DATE	FACILITY PLATE NO.	SHEET
HELIPAD PERIMETER LIGHTING CONFIGURATION	SEP 95	136-65	1 of 6



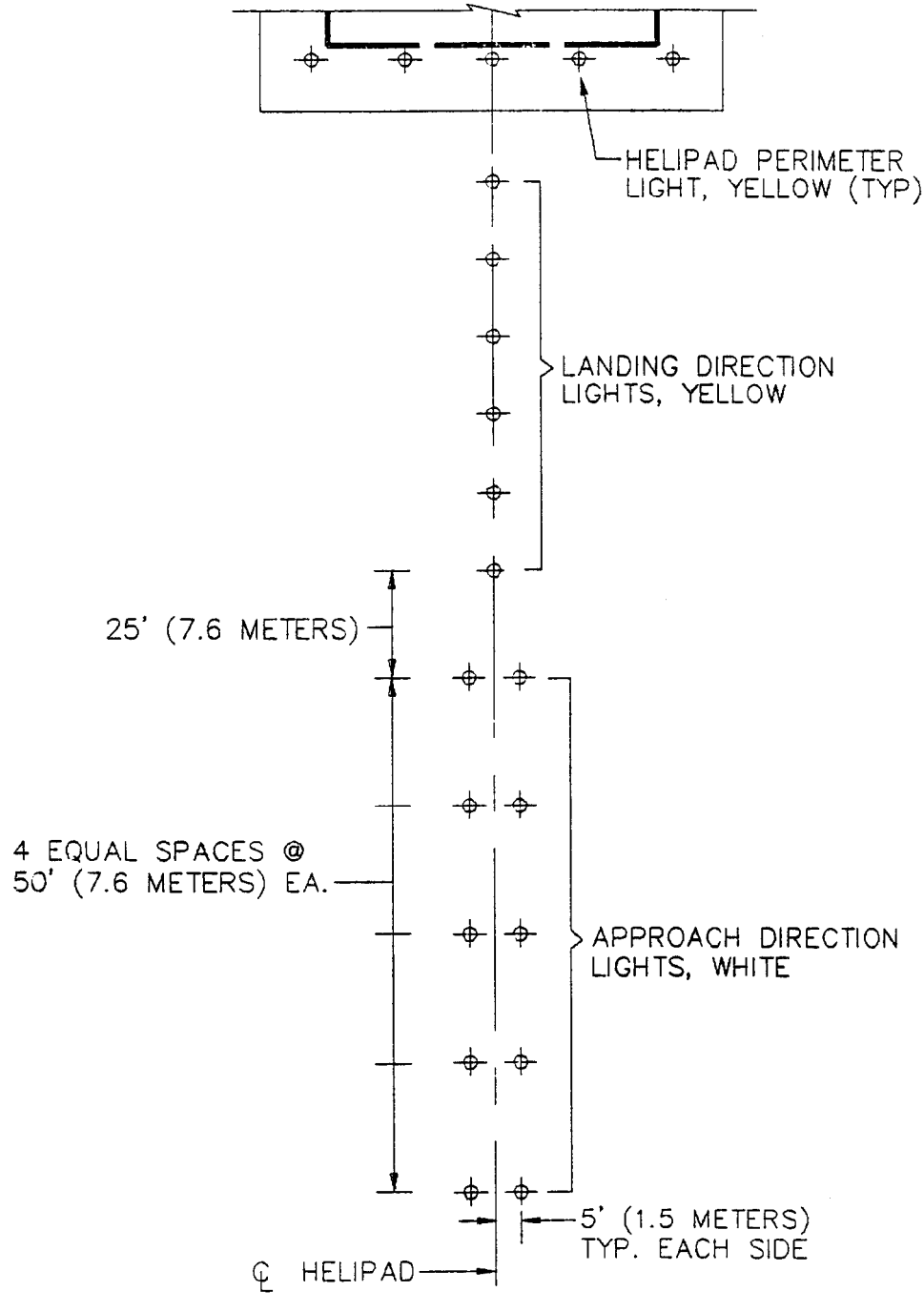
NOTE:
SEE FACILITY PLATE NO. 136-65
SHEET 6 of 6 FOR HOSPITAL
HELIPAD MARKINGS.

TITLE	DATE	FACILITY PLATE NO.	SHEET
HOSPITAL HELIPAD PERIMETER LIGHTING CONFIGURATION	SEP 95	136-65	2 of 6

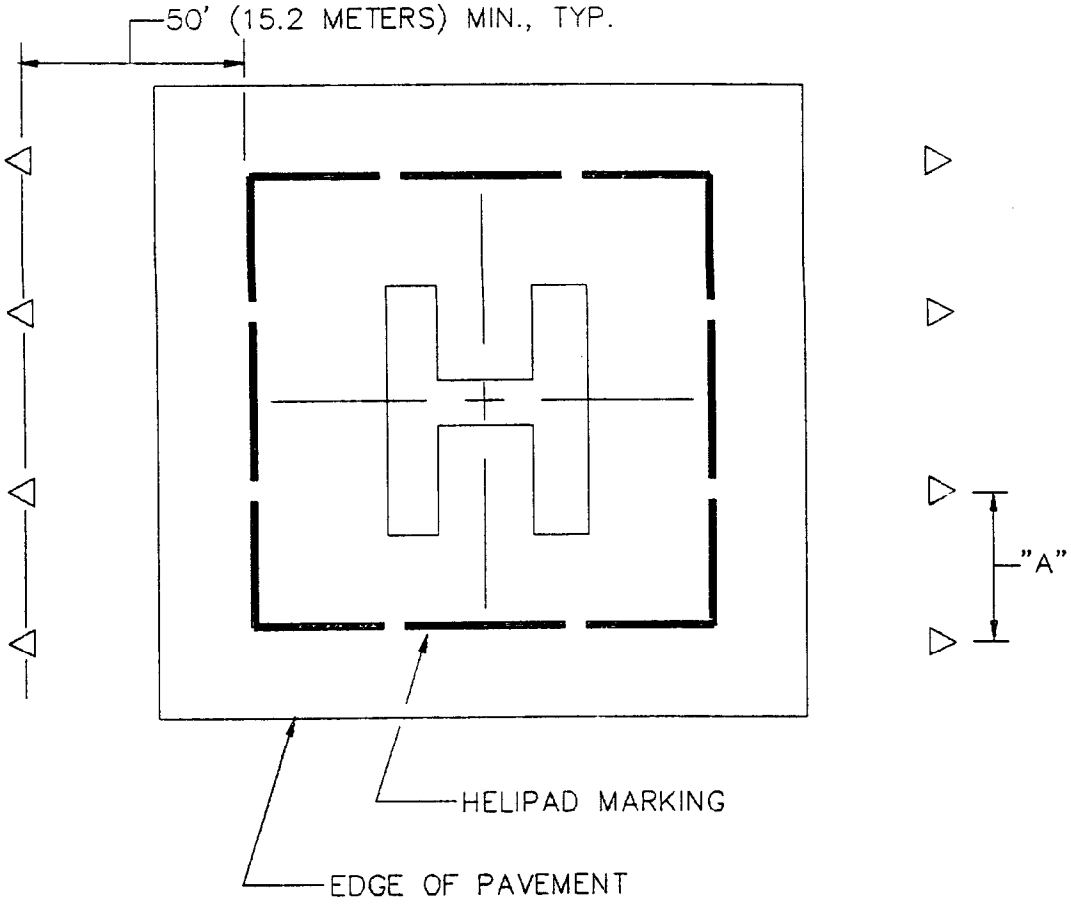


NOTE:
LANDING DIRECTION LIGHT CONFIGURATION FOR HOSPITAL HELIPAD SHALL START 25' (7.6 METERS) FROM THE OUTER PERIMETER LIGHT SHOWN ON FACILITY PLATE NO. 136-65 SHEET 2 OF 6.

TITLE	DATE	FACILITY PLATE NO.	SHEET
LANDING DIRECTION LIGHT CONFIGURATION	SEP 95	136-65	3 of 6



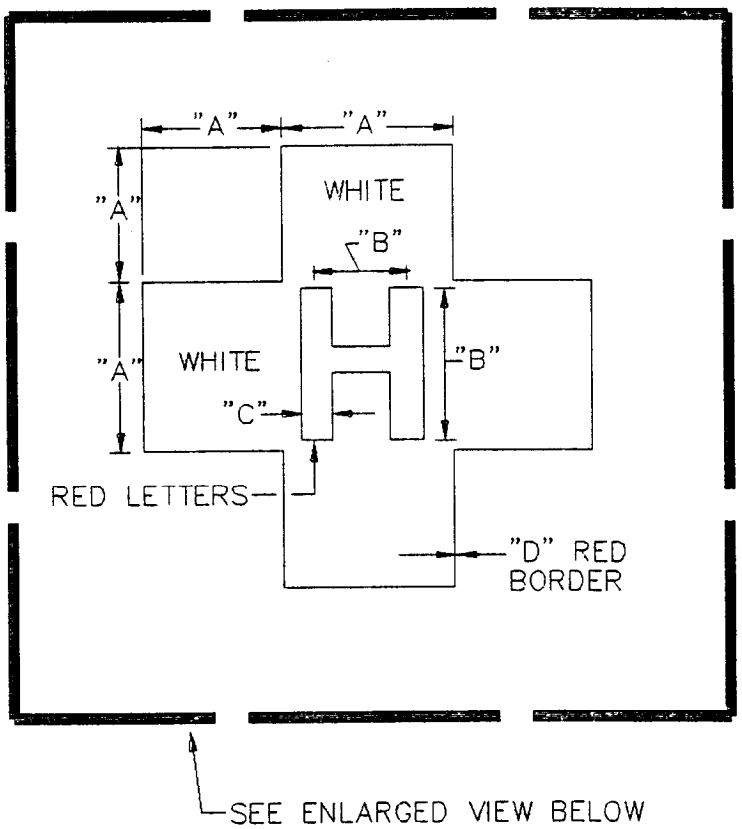
TITLE APPROACH DIRECTION LIGHT CONFIGURATION	DATE SEP 95	FACILITY PLATE NO. 136-65	SHEET 4 of 6

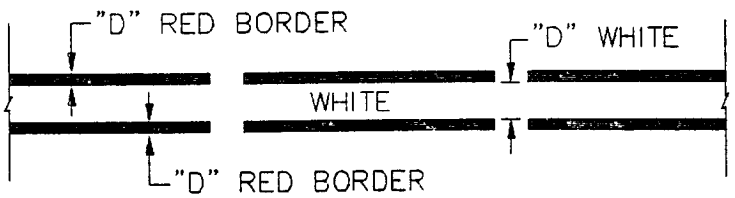


◁ FLOODLIGHT

"A" SPACING BETWEEN LIGHTS WILL BE DEPENDENT ON NUMBER AND TYPE OF LIGHTS REQUIRED AND BY THE SIZE OF THE HELIPAD

TITLE	DATE	FACILITY PLATE NO.	SHEET
HELIPAD FLOODLIGHT CONFIGURATION	SEP 95	136-65	5 of 6





ENLARGED VIEW

A - 10 (3.1 METERS)
B - 5.5 (1.7 METERS)
C - 18 (457 MILLIMETERS)
D - 6 (153 MILLIMETERS)

NOTE:
RETROREFLECTIVE PAINT OR TAPE SHALL BE IN ACCORDANCE WITH TT-P-85E AND TT-P-1952. RED COLOR SHALL BE:
RED - 11350 FROM FED-STD-595

TITLE	DATE	FACILITY PLATE NO.	SHEET
HOSPITAL HELIPAD (ONLY) MARKINGS	SEP 95	136-65	6 of 6

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Section 7: APRON, PARKING AREA AND DIRECT FUELING STATION LIGHTING

7.1 General. Safe and efficient movement of aircraft in the terminal, hangar, parking and service areas depends to a great extent on an adequate system of marking and lighting to perform the required functions. The basic design philosophy is to provide sufficient illumination in these areas to permit the day markings to be seen, and used at night and to permit the accomplishment of general tasks and movements without supplemental lights. It is expected that some tasks and situations will require supplemental lighting. It is intended that the use of signal lights (e.g. edge lights or taxilane lights) will be kept at a minimum.

7.2 Definitions. For the purpose of clarity the following definitions are offered in connection with the requirements of this section:

a) Apron - an area intended to accommodate aircraft for the purpose of loading or unloading cargo or personnel, or for servicing of aircraft.

b) Aircraft Stand - a location within an apron identified for parking of aircraft during the loading, unloading or servicing activity.

c) Parking Area - an area intended to hold inactive aircraft between missions.

d) Taxilane - a route through an apron or parking area reserved for the movement of aircraft or other vehicles within the area.

7.2.1 Direct Fueling Stations. A permanent refueling point established to permit rapid refueling and turnaround of aircraft on multiple missions. Lighting requirements for these facilities are unique, and the general requirements of this section do not apply.

7.3 Apron and Parking Area Lighting (Cat Code 136-20)

7.3.1 Description. Apron and parking area lighting are combinations of floodlights, taxilane lights and signs which: provide lighting suitable for the loading and unloading of cargo and personnel and for refueling and other apron service functions; provide lighting and guidance suitable for the movement of cargo, personnel, aircraft and other vehicles throughout the area; and provide lighting to enhance the security of stored aircraft. The system contains the following elements:

a) Floodlighting which provides overall illumination.

b) Taxilane lighting installed only as required where the visibility of taxilane marking is inadequate.

c) Peripheral lighting which outlines the limits of the apron or parking area when other means of identification are inadequate.

7.3.2 Floodlighting. The configuration of floodlights is predicated on the light output of the fixtures selected and the design considerations defined in paragraph 7.3.2.1.

7.3.2.1 Illumination Levels. Apron and parking areas require an average luminance of 1 footcandle (10 lux) overall with a uniformity ratio not greater than 4 to 1 (average to minimum). Where the size of the apron or parking area is large and its location or configuration prohibit the use of floodlighting towers away from the building line, the illumination levels may be reduced and the contrast ratios may be increased as circumstances dictate. Aircraft stands require floodlighting enhanced to an average of 2 footcandles (20 lux).

7.3.2.2 Control of Glare. Light distribution shall be controlled to prevent glare toward the control tower or approaching aircraft. Disability and discomfort due to glare shall be kept to a minimum by proper location of lights and direction of beams and by appropriate selection of light source and luminaire type. In addition, positive shielding of any “spill light” above the horizontal level should be accomplished using louvers, louver grids, or baffles. Means shall be provided to adjust luminaires to change light direction. In order to minimize glare problems for pilots and aircraft service personnel in the area, floodlights should be mounted as high above the surface as practical within the confines of obstruction clearance planes. A mounting height of 50 ft (15.2 m) or higher is recommended but in no case should the mounting height be lower than 30 ft (9.1 m).

7.3.2.3 Fixtures. Floodlighting fixtures conforming to NEMA Standard FA-1, Type HD with gas discharge lamps should be utilized in the design.

7.3.2.4 Supports. Floodlight fixtures may be mounted on buildings or on floodlight support structures. Support design should include considerations for access to the fixtures for maintenance.

7.3.2.5 Electrical requirements. Floodlights are connected to multiple circuits of a voltage suitable for the fixture and lamp selected. Floodlights should be connected to 3-phase power source with lights connected to all three phases so as to provide a balanced load on all three phases and to reduce the stroboscopic effect of gas discharge lamps.

7.3.2.6 Control requirements. Floodlighting requires on/off control in the lighting vault and at the control tower or other locations accessible to ground service personnel as ordered.

7.3.3 Peripheral Lighting. Peripheral lighting is installed wherever it is necessary to identify the limits of usable pavement for aprons or parking areas, ordinarily only those limits not already defined by buildings, hangars, etc. Peripheral lighting consists of blue taxiway edge lights installed, powered, and controlled in accordance with the criteria of para. 4.1. On/off control is coupled with the floodlight controls.

7.3.4 Taxilane Lighting. Taxilane lighting is only installed where floodlighting is inadequate and impractical to be improved sufficiently to permit proper identification and visibility of taxilane markings. Taxilane lighting consists of green taxiway centerline lights installed, powered and controlled in accordance with the criteria contained in para. 4.2. Where movement over the taxilane is in one direction only, bidirectional fixtures may have one direction blanked. Taxilane lights controls are required in the lighting vault and in the control tower or as directed.

7.4 Direct Fueling Stations. Lighting for direct fueling stations consist of taxiway edge lights installed in accordance with para. 4.1, guidance signs installed in accordance with para. 4.5 and floodlights frangibly mounted no higher than 4.5 ft (1.4 m) above the pavement. Floodlights conforming to Naval Engineering Center Drawing 615902, Floodlight Assembly, Night Vision Type, should be used whenever possible. Where these cannot be made available floodlights conforming to NEMA Standard FA-1 type HD should be used. They should be designed and aimed to provide an average vertical luminance of 2 footcandles (20 lux) with a uniformity ratio of 4 to 1 for the full width of the refueling lane for a distance of 25 ft (7.6 m) either side of the mechanical control panel. They should emit no light above the horizontal. On/off controls for all direct fueling station lights will be provided at the fueling lanes.

7.5 Additional Design Guidance. Although the publications listed below may not be in complete agreement with this handbook, they contain significant information to assist in the design of taxiway edge lighting systems. Where conflict exists between this handbook and the sources listed below, this handbook takes precedence:

a) NAVFAC P-272 Definitive Design Drawings:

1403042 Airfield Lighting, Direct Fueling Station

b) ICAO Publications:

Aerodrome Design Manual Part 4, Visual Aids Chapter 13 Apron Floodlighting.

c) Guide Specifications:

NFGS 16560 Guide Specification for Airfield Lighting

7.6 Compliance With International Military Standards

The standards of this handbook do not comply with ASCC Air Standard 65/18, Movement Area Floodlighting, or with NATO STANAG 3892, Movement Area Floodlighting.

Section 8: PORTABLE EMERGENCY AIRFIELD LIGHTING

8.1 General. In times of emergency, when standard airfield lighting is not available and aircraft operations must be performed at night, it may be necessary to resort to the use of portable lighting devices to support the operations. The lighting design standards contained in this section may be suitable for use in VFR night operations but do not qualify the airfield for instrument operations of any kind. The standards in this section cover runway, taxiway, and helipad lighting only. These standards do not cover requirements for forward tactical airfields or landing zones. Care should be taken when installing portable lights that they are secured sufficiently to prevent movement as a result of jet blast or other forces. When application of the criteria in this section would result in a light location in an active paved area, the light shall be omitted or relocated as circumstances dictate.

8.2 Runway Lighting

8.2.1 Runway Edge Lighting. Portable edge light configurations generally follow the standard configuration except that the spacing may be increased to the maximum of 300 ft (91.4 m) and the offset may be increased to a maximum of 10 ft (3.05 m) from the runway edge. The runway edge lights shall be white.

8.2.2 Runway End and Threshold Lighting. The number of lights required for runway end and threshold lights is reduced to 10. At each end of the runway they shall be placed in two groups of 5 with the outermost lights in each group in line with the line of the runway lights and spaced at 10 ft intervals toward the center. The line of threshold and runway end lights may be offset no more than 5 ft (1.5 m) from the end of the runway. The lights shall be red toward the runway and green toward the approach.

8.3 Taxiway Edge Lighting. The techniques for designing an emergency taxiway edge lighting system are generally the same as for a standard system except that the spacing is increased as follows:

a) Straight Sections - The spacing shall not exceed 220 ft (67 m).

b) Curved Sections - The spacing shall not exceed 100 ft (30.4 m).

8.4 Helipad Lighting. Emergency helipad lighting shall follow the standard configurations for perimeter, landing direction, and approach direction lighting except that adherence to light plane criteria is not required.

8.5 Fixtures. Fixtures may be omnidirectional, bidirectional or unidirectional. Where unidirectional fixtures are employed, they must be aimed in the direction of the planned operation. If the operational direction changes they must either be reoriented to accommodate the change or additional lights must be installed for the new direction. Unidirectional fixtures generally have better light output for the energy being consumed than the other types. Omnidirectional fixtures meeting MIL-L-19661A, Light, Marker, Portable, Emergency Airfield, Battery Operated, Type 1 may be used with

filters as appropriate for the application. Unidirectional and bidirectional fixtures meeting FAA AC 150/5345-50, Portable Runway Lights, may also be used. Other portable fixtures that are suitable for outdoor use, meet the duty cycle requirements and which meet or exceed the light output of the specified fixtures may be considered. Such considerations may include lights with nonelectric power sources.

8.6 Controls. The specified lights have individual on/off controls and are not capable of control from a central point. They may have been provided with a flashing mode which shall not be used during periods when aircraft operations are being conducted.

8.7 Compliance With International Military Standards. These standards comply with NATO STANAG 3534, Airfield Portable Lighting, Edition 2 and ASCC Air Standard 65/8B, Airfield Portable Lighting Systems, except for light output of the fixtures.

BIBLIOGRAPHY

FAA Advisory Circulars may be obtained from the Department of Transportation publication section, M-494.3, Washington, D.C. 20590. Request the latest edition.

FAA AC 150/5345-5	Circuit Selector Switch
FAA-E-2159	Runway End Identification Lighting System (REIL)
FAA D 5888 Series	Runway End Identifier System (REIL)

International Civil Aviation Organization (ICAO), publications available for a fee. Contact the Document Sales Unit, ICAO, 1000 Sherbrooke Street West, Suite 400, Montreal, Quebec, Canada, H3A 2R2 for ordering information.

ICAO Part 5	Aerodrome Design Manual, Electrical Systems

Military Specifications and Standards, available from Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120. Telephone Number: Autovon 442-3321; Commercial (215) 697-3321; TWX (710) 670-1685.

MIL-P-9845	Panel, Relax, Pilot, Enclosed, Airport Lighting
MIL-L-81015	Lampholder, PAR 46/64, Aviation Lighting

Naval Air Engineering Center (NAEC), drawings available from Naval Air Technical Services Facility, 700 Robbins Avenue, Philadelphia, PA 19111.

NAEC DWG. 621285	Installation Details for Simultaneous Operation of Waveoff Lights and Runway Waveoff Lights

Naval Facilities Engineering Command (NAVFAC) Design Manuals, Guide Specifications and P-Publications, available from Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120. Telephone Number: Autovon 442-3321; Commercial (215) 697-3321; TWX (710) 670-1685.

NAVFAC DM-2	Structural Engineering Series
NAVFAC DM-4	Electrical Engineering Series
NAVFAC DM-5	Civil Engineering Series
NAVFAC DM-21.1	Airfield Geometric Design
NAVFAC DM-21.6	Airfield Pavement Markings
NAVFAC P-80	Facilities Planning Criteria for Navy and Marine Corps Shore Installations
NAVFAC P-80.3	Airfield Safety Clearances

REFERENCES

The publications listed below are referenced in this handbook and provide additional guidance. Copies of these references are obtainable by Government agencies as indicated.

FAA Advisory Circulars, may be obtained from the Department of Transportation, Publication Section, M-494.3, Washington, D.C. 20590. Request the latest edition.

AC 150/5340-4	Installation Details for Runway Centerline and Touchdown Zone Lighting Systems
AC 150/5340-17	Standby Power for Non-FAA Airport Lighting Systems
AC 150/5340-18	Standards for Airport Sign Systems
AC 150/5340-19	Taxiway Centerline Lighting Systems
AC 150/5340-24	Runway and Taxiway lighting Systems
AC 150/5345-1	Approved Airport Lighting Equipment
AC 150/5345-3	Specification for L-821 Panels for Remote Control of Airport Lighting Systems
AC 150/5345-7	Specification for L-824 Underground Electrical Cable for Airport Lighting Circuits
AC 150/5345-10	Specification for L-828 Constant Current Regulators
AC 150/5345-13	Specification for L-841 Auxiliary Relay Cabinet Assembly for Pilot Control of Airport Lighting Circuits
AC 150/5345-26	Specification of L-823 Plug and Receptacle, Cable Connectors
AC 150/5345-42	FAA Specification L-857, Airport Light Base and Transformer Housings, Junction Boxes and Accessories
AC 150/5345-44	Specification for Taxiway and Runway Signs
AC 150/5345-45	Lightweight Approach Light Structure
AC 150/5345-46	Specification for Runway and Taxiway Light Fixtures
AC 150/5345-47	Isolation Transformers for Airport Lighting Systems
AC 150/5345-50	Specification for Portable Runway Lights
AC 150/5345-51	Specification for Discharge Type Flasher Equipment

FAA Standards Specifications and Drawings, are available from the Federal Aviation Administration, Program Engineering and Maintenance Service, Washington, D.C. 10591.

FAA Equipment Specifications:

FAA-E-910	Structural Steel
FAA-E-982G	PAR-56 Lampholder
FAA-E-1315	Light Base and Transformer Housing
FAA-E-2204	Specification for Diesel Engine Generator Sets, 5KW to 300KW
FAA-E-2325	Medium-Intensity Approach Light System with Runway Alignment Indicator lights (MALSR)
FAA-E-2604	Low-Impace-Resistant Structures for Medium-Intensity Approach Lighting Systems
FAA-E-2628	Sequenced Flashing Lighting System, Elevated and Semiflush with Dimming and Monitoring
FAA-E-2651	Omnidirectional Approach Lighting System (ODALS)

FAA-E-2689	Dual Mode High Intensity Approach Lighting System (ALSF-2/SSASR)
FAA-E-2690	Isolation Transformer for Approach Lighting System (1500 watt)
FAA-E-2702	Low Impact Resistant Structures

FAA Construction Specifications:

FAA-C-2626	Construction of A Medium-Intensity Approach Lighting System with Runway Alignment Indicator Lights (MALSR) and of A Runway End Identifier Light System (REIL)
FAA-C-2722	Construction of a High-Intensity Approach Lighting System with Sequenced Flashing Lights for Category II (ALSF-2) Runways

FAA Drawings

C 6046A	Frangible Coupling, Type 1 and Type 1A, Details
D 6076 Series	ALSF-2 Approach lighting System 6'-0" to 40'
D 6131 Series	High-Intensity Approach Lighting System with Sequenced Flashing Lights (ALSF-2)
D 6155 Series	ALSF-2, 6' to 128' and MALS 40' to 128', LIR Structures
D 6213 Series	MALSR with Threshold lights and Low-Impact-Resistant Structure

International Civil Aviation Organization (ICAO), available for a fee. Contact the Document Sales Unit, ICAO, 1000 Sherbrooke Street West, Suite 400, Montreal, Quebec, Canada, H3A 2R2 for ordering information.

Annex 14	International Standards and Recommended Practices, Aerodromes
Part 4	Aerodrome Design manual, Visual Aids

International Military Standards. Copies of NATO STANAGS and ASCC Air Standards are available from U.S. Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 10120. Telephone Number: Autovon 442-3321; Commercial (215) 697-3321. TWX (710) 670-1685.

NATO STANAGS

3316	Airfield Lighting
3534	Airfield Portable lighting
3652	Helipad Lighting (VMC)
3892	Movement Area Floodlighting

ASCC Air Standards

65/1	Airfield Runway Lighting
65/4	Airfield Approach lighting
65/8	Airfield Portable Lighting Systems
65/9	Taxiway Lighting
65/12	Category II Airfield Lighting and Marking Standards
65/16	Helipad Lighting (VMC)
65/17	Airfield Signs
65/18	Movement Area Floodlighting

Military Specifications and Standards, available from Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120. Telephone Number: Autovon 442-3321; Commercial (215) 697-3321; TWX (710) 670-1685

MIL-P-4971	Panel, Control Transfer, Airport Lighting, Type MB-1
MIL-L-5904	Light, Runway Marker, Elevated, Type C-1
MIL-L-7082	Light, Runway Marker, Elevated, Type M-1
MIL-P-8944	Panel, Airport Lighting Control, General
MIL-C-26885	Cubical, Power Distribution Automatic Transfer, Airfield Lighting (ASG)
MIL-B-8954	Base and Accessories, Airport Marker Lights
MIL-L-19661	Light, Marker, Portable, Emergency, Airfield, Battery Operated
MIL-G-19826	Generator Sets, Diesel Engine, Alternating Current, 10KW Through 500KW
MIL-L-22252	Circling Guidance Light, Specification
MIL-L-26202	Light, marker, Airport, Semiflush
MIL-L-26764	Light, Marker, Approach, High Intensity, Type MB-2
MIL-C-25050	Colors, Aeronautical Lights and Lighting Equipment
MIL-L-26990	Light, Marker, Airport Approach, High Intensity, Type MB-l
MIL-T-27535	Transformer, Power, Isolation, Series Circuit

National Electrical Manufacturers Association (NEMA) Publication, available from NEMA, 2101 L Street, NW, Suite 300, Washington, D.C. 20037.

NEMA FA-1	Outdoor Floodlighting Equipment

Naval Air Systems Command (NAVAIR) Publications, available from Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120. Telephone Number: Autovon 442-3321; Commercial (215) 697-3321; TWX (710)

NAVAIR 51-50AAA-2	Technical Manual, General Requirements for Shore Based Airfield Marking and Lighting

Naval Air Engineering Center Drawings (NAEC), available from Naval Air Technical Services Facility, 700 Robbins Avenue, Philadelphia, PA 19111.

NAEC DWG. 615902	Floodlight Assembly, Night Vision Type

Naval Facilities Engineering Command (NAVFAC) Design Manuals, Guide Specifications and P- Publications, available from Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120. Telephone Number: Autovon 442-3321; Commercial (215) 697-3321; TWX (710) 670-1685

NAVFAC DM-21	Airfield Pavement Design Series
NAVFAC DM-23.02	Navigation and Traffic Aids
NFGS-01011	Additional General Paragraphs
NFGS-16560	Airfield Lighting
NAVFAC P-272	Definitive Design Drawings
1403042	Airfield Lighting, Direct Fueling Station
1404275	Approach Lighting System, Plan Layout Elevation/Aiming Plan, Visibility Plan

1404276	Approach Lighting System, Approach Lighting Vault, One Line & Block Diagram
1404277	Approach Lighting System, Series Wiring, Fixture Schedule, Circuit Load Schedule
1404278	Approach Lighting System SFL Wiring Diagram & Substation
1404279	Approach Lighting system, Threshold, 500 Foot 7 Wing Bars, Road Sections
1404280	Approach Lighting System, Terminating, 1000 Foot Cross and Centerline Bars
1404281	Approach Lighting System, Light Bar Sections, Tower and Miscellaneous Details
1404282	Runway Lighting, Edge Lights and Distance Markers-Plan
1404283	Circling Guidance, Touchdown Zone, & Centerline Plans & Typical Wiring
1404284	Identification & Edge light Installation Details & Schedule
1404285	Circling Guidance & Edge Light Installation Details & Schedule
1404286	Touchdown Zone 7 Threshold lights Installation Details
1404287	Inset Fixture 7 Wiring Installation Details
1404288	Duct Line Plan & Handhold Details
1404289	Simulated Carrier Deck Lighting, Plan & Wiring Diagram
1404290	Simulated Carrier Deck Lighting Details
1404510	MALSR, Plan and General Details
1404511	MALSR, System Riser Diagram
1404512	MALSR, System Schematic Diagram
1404513	MALSR, Equipment Mounting Details
1404514	MALSR, Tower and Foundation Details
1404515	MALSR, 1000 Foot Cross Bar and Foundation Details

Rural Electrification Administration (REA) Bulletins, available from U.S. Department of Agriculture, Rural Electrification Administration, Information Services Division, Washington, D.C. 20250.

Bulletins

345-14	Specification PE-23 for Telephone Cables for Direct Earth Burial
345-67	Specification P-39 for Filled Telephone Cables

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b. ADDRESS *(Street, City, State, ZIP Code)*	☐ USER
	☐ MANUFACTURER
	☐ OTHER *(Specify)*:

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a. Paragraph Number and Wording:

b. Recommended Wording:

c. Reason/Rationale for Recommendation:

6. REMARKS

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